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Australian Geographic Society

Australian GEOGRAPHIC

MAY – JUNE 2025

IT'S IN OUR NATURE

Frogs

JUST HANGING ON

FAIRYTALE OUTCOME
FOR A RARE BEAUTY

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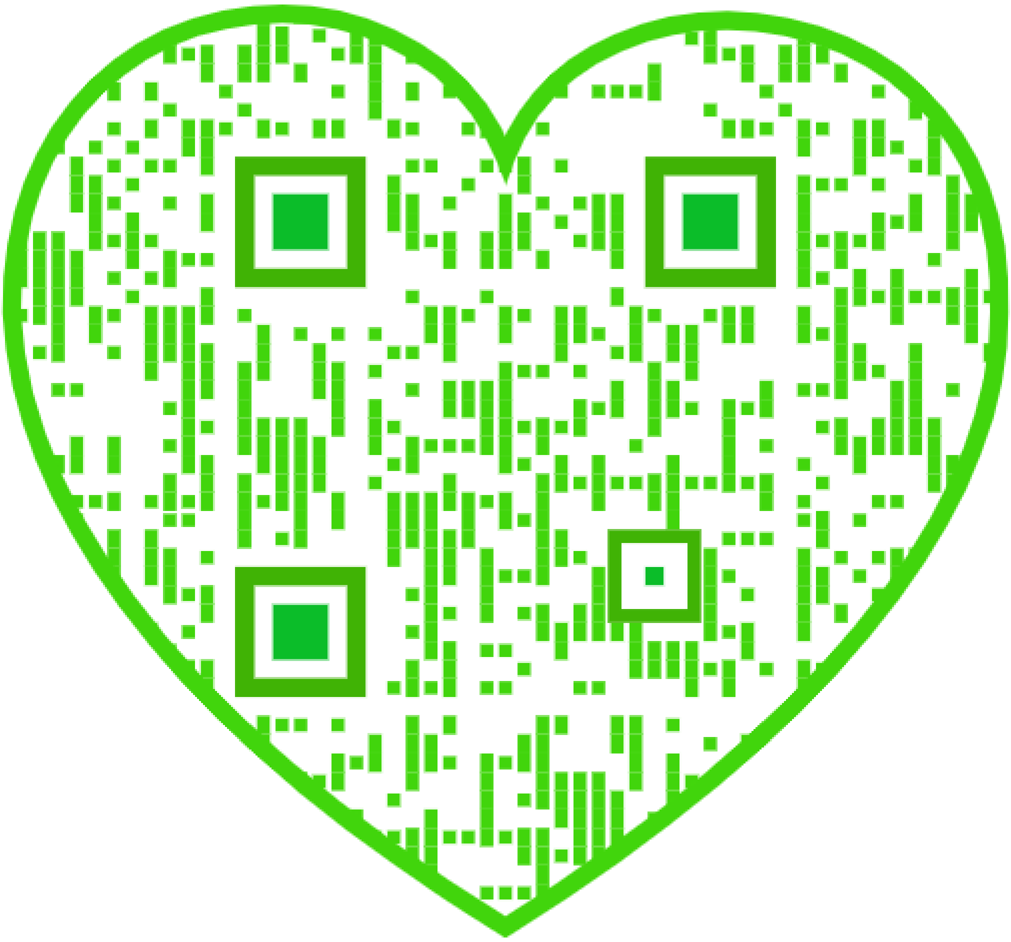
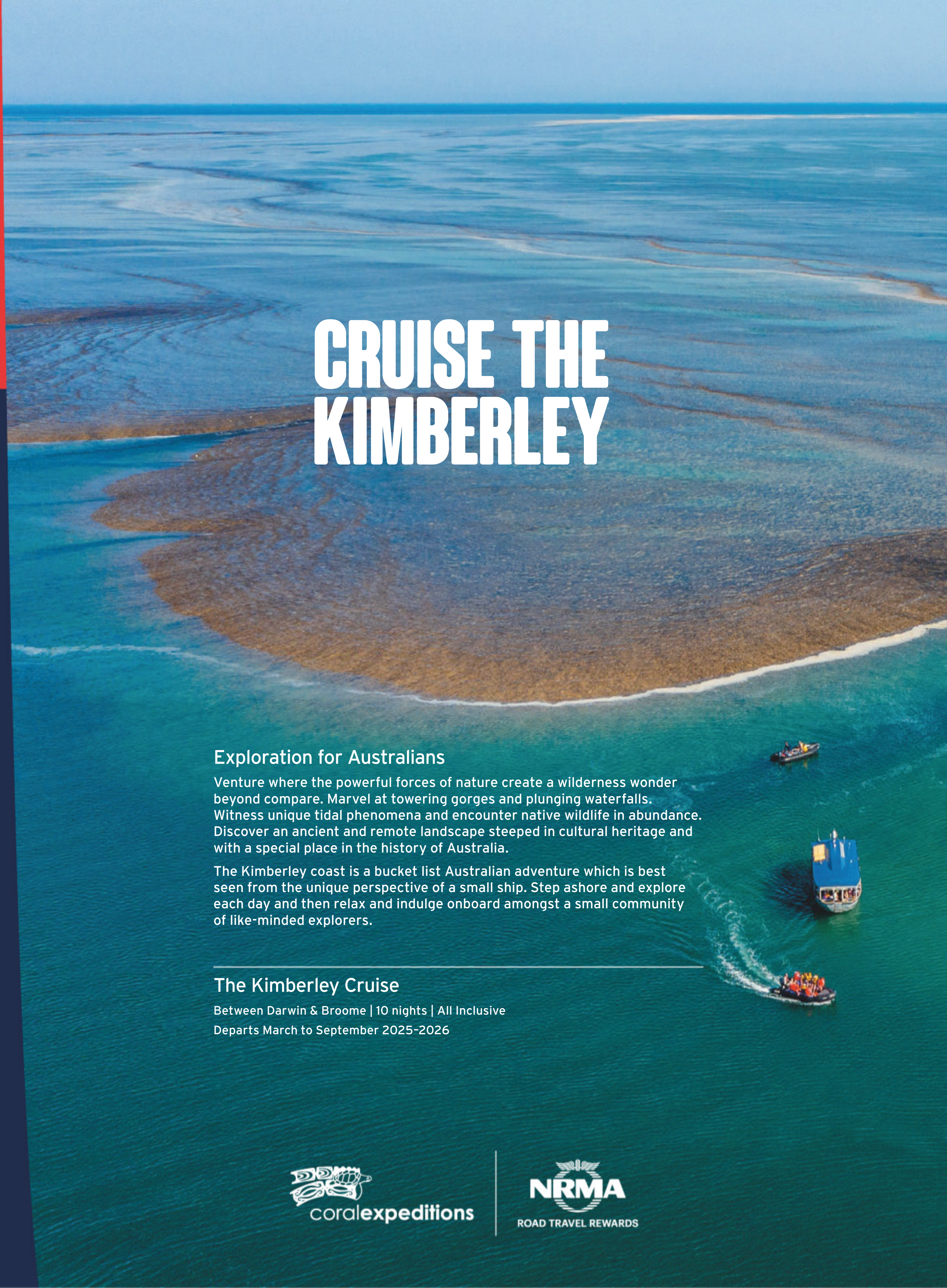
YES WE CAN!

PLASTIC PROBLEMS
FANTASTIC SOLUTIONS

NELLIE MELBA
OUR FIRST STAR





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1. Mirror Waters of the Gordon River

Given their colour by amber button grass tannins – are as eerie as they are beautiful on **Tassie's Wilderness Icons** tour, with the mirror-like surface only broken by your chariot out to Sarah Island. Early settlers didn't mince their words when they called the treacherous entrance to the river's harbour Hells Gates, something you'll understand when you drift past.

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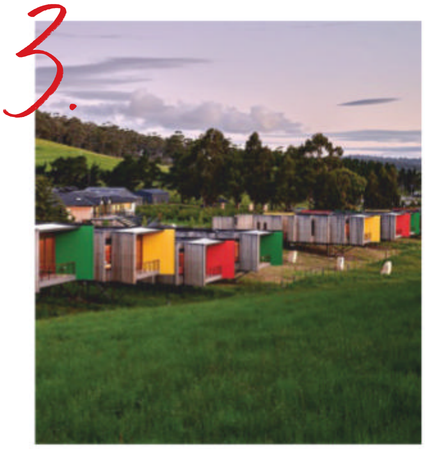
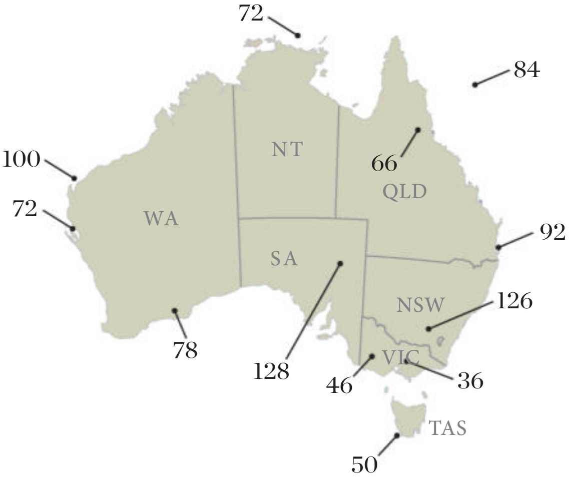


4. Treasures and Tastes at Salamanca Market

From alpaca throws to woodwork, gin to garden-fresh vegetables, pottery, books and buskers, visit Salamanca Market on your **Perfect Tasmania** tour. Discover creative Tassie in a bustling snapshot where you can grab a coffee before navigating more than 300 stalls wedged alongside the precinct's historic sandstone warehouses.

5. Port Arthur's Haunting Heritage

While the World Heritage-listed Port Arthur Historic Site has a grim convict history, you wouldn't know it today with its rolling green fields and ocean views, best glimpsed on **Tassie's East Coast Highlights** tour with an in-the-know historian who can reveal secrets as you cruise around the Isle of the Dead.



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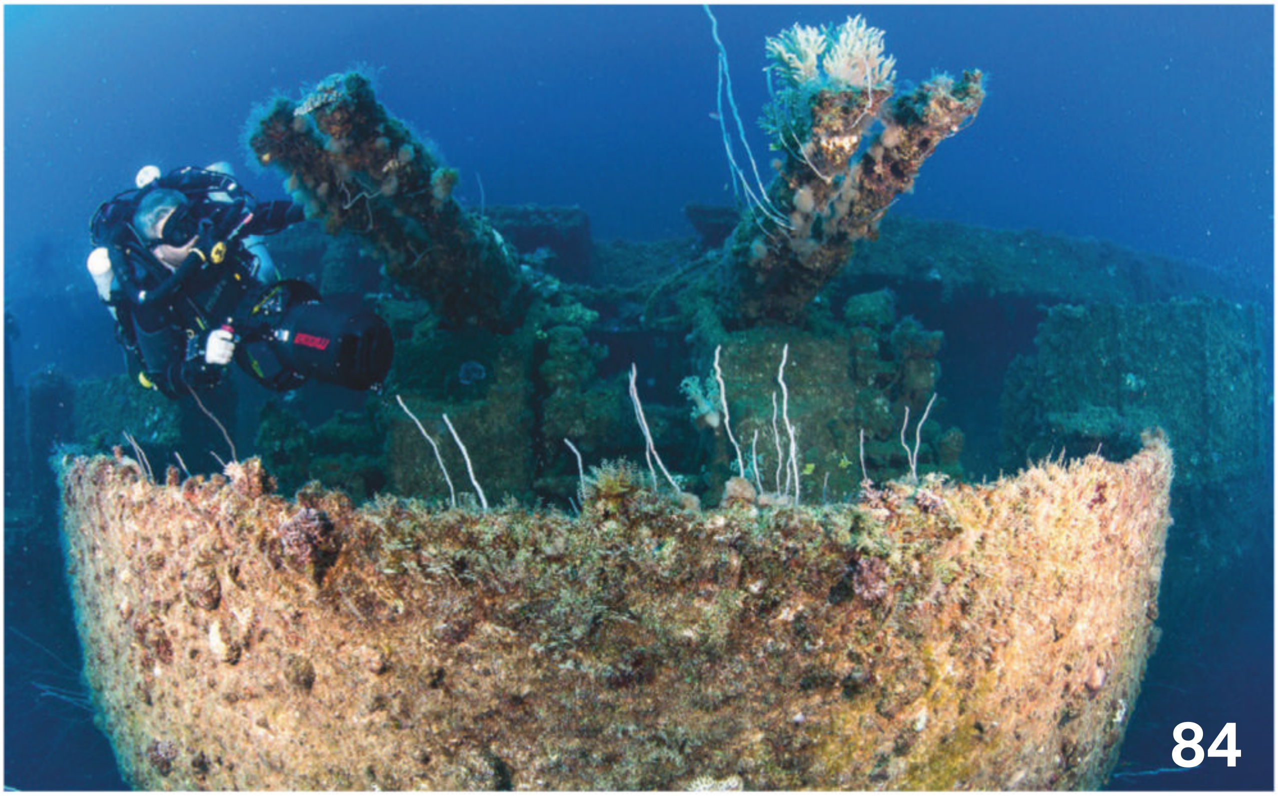

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PHOTO CREDIT: DAMIEN SIVIERO

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YOUR SOCIETY
Find out where your donations are going in 2025 and get the latest news. **p32**

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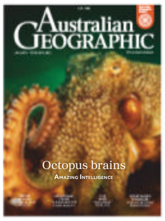
Special note: Members of First Nations communities are warned that this edition of Australian Geographic may contain images and names of deceased people.

PHOTO CREDITS, CLOCKWISE FROM TOP LEFT: ZOOS VICTORIA; DON FUCHS; YARRA RANGES COUNCIL; DUNCAN WRIGHT; MICHELINE JENNER

Australian Geographic
Frogs

ON OUR COVER

Jasmine Vink captured this Australian lacelid (*Litoria dayi*). Sadly, the species has declined in much of its higher altitude range due to chytrid and is classified as endangered.



Australian Geographic
Recovering curlews

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Distance matters

MANY OF OUR older readers would have heard the term 'the tyranny of distance'. And they'd know how it was used by historian Geoffrey Blainey to describe the way modern Australia has been shaped culturally and economically by its isolation from the rest of the world.

Our younger readers might not have heard of it, but during the COVID years would certainly have felt the impact of being geographically isolated. For Aussies living away from the major cities, isolation is the norm and continues to be a challenge – even in an era of immense interconnectedness shaped by the internet and smartphones.

So, what do people in country towns or living in 'the back of beyond' do when they encounter a challenge that can't be fixed with a trip to the local mechanic, supermarket, university or airport? Quite simply, they deal with it. And, as you'll see in our story *On the snail trail* (page 78), their solutions are often highly imaginative.

"A report by the Regional Australia Institute found that during the global financial crisis in 2009, when city-based growth was slowing, regional Australia took up the slack and contributed 50 per cent of national economic growth," our story reports. "Even when times had improved by 2022, the regions accounted for 34 per cent of GDP." Moreover, they have the potential to boost the economy by $25 billion.

In fact, we were so impressed by what we've been hearing about regional innovation that we've decided the story in this issue will be the first of a series on the topic. So, stay tuned for more in the next couple of issues. And do let me know of any other examples you know of.

I'm aware I go on a lot about this magazine's extensive coverage of Aussie life well beyond the major population centres along the east coast, and how it sets us apart from most media. But it's something I'm incredibly proud of!

And so, elsewhere in this issue we take you to Western Australia and the remarkable marine mammals now thriving off its coast; to a retreat for people with autism and their families in Victoria's High Country; on an exploration of our earliest export – sea cucumbers – off the Arnhem Coast in the Northern Territory; and on a celebration of the remarkable biodiversity of southern Tasmania.

As we head towards our 40th anniversary next year, we look forward to continuing to bring you exceptional storytelling from all corners of this extraordinary continent… and sometimes beyond.

K McGhee

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AUSGEO TRAVEL

The AG Travel team recently had the privilege of learning more about two of Australia's most remarkable birding and conservation areas – Gluepot Reserve and Bowra Wildlife Sanctuary. Gluepot, tucked away in South Australia's mallee, is a haven for rare birds like the black-eared miner (pictured), thriving in its protected, arid landscapes. Bowra, set in Queensland's mulga woodlands, is where the Hall's babbler and the elusive grey falcon can be spotted. Both sanctuaries are run by passionate conservationists and volunteers, ensuring these vital habitats remain untouched. Visiting them is more than just birdwatching – it's a chance to support ecotourism and witness Australia's incredible biodiversity firsthand.

Bryan Arnicar
General Manager
Australian Geographic Travel

PHOTO CREDIT: SHUTTERSTOCK

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Dubbo AND THE Great Western Plains

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NOTES FROM THE FIELD

Regional trailblazing

THE INNOVATION COMING out of regional Australia now is so exciting that we're devoting a three-part series to the topic, beginning with *On the snail trail* (page 78). To shoot the series we called on the talents of Western Australia-based photographer **DUNCAN WRIGHT**, who's great with both people and places. "I love getting a call-up for an assignment that allows me to have a creative and flexible approach to image-making," he says. "This job was exactly that: travelling to three far-flung corners of Australia – Esperance in WA, Murrumbateman in regional NSW and the Torres Strait Islands – to meet inventors who'd come up with wild and wide-ranging ideas to solve their own unique issues. All three shoots were set in these vast landscapes. I wanted to show how hard regional innovators have to work simply because the next closest anything isn't just around the corner, but around many."

The first story in the series highlights the wonderful work of SnailCam in Esperance. "We shot in the baking midday sun on an incredible farming property," Duncan says. "While everything around us was vast – the tractors, the landscape, the sky – I was there to photograph these tiny snails. My macro adapters weren't picking them up, so I did an old trick and reversed my camera lens to get the shot, also revealing the minutiae of Rain Plaado's hardworking hands."

Duncan Wright reflects on his time on a beach in the Torres Strait.

Not every shoot went as planned. "We had talent lined up for the Howdy app [see next issue] shoot in Murrumbateman who became unavailable at the very last minute," Duncan says. "So we had to reconsider the brief. I began thinking of the ways regional people would have met and communicated in the past – hitchhiking, sitting in a pub, playing pool, by post – these were all scenes we shot on the fly to try and illustrate the story of a dating app for farmers. Fortunately, we got a call from a local who kindly let us shoot on their property with massive cows and a beautiful horse."

Duncan's shoot with Dennis Fay on Thursday Island in the Torres Strait [keep an eye out for issue 188] was another highlight. "After flying up from Canberra, we spent the afternoon shooting and exploring these immensely beautiful yet rubbish-strewn beaches by boat. We wrapped up once the sun had set on this tropical paradise. But instead of going to the pub for dinner, Dennis had been invited to a local teen's 18th birthday party, where we caught up with some of his old friends and ate local foods for dinner."

Regular columnists: Glenn Dawes, Bruce Elder, Dr Karl Kruszelnicki AM, Kel Richards, Roger Smith, Fred Watson AM, Tim the Yowie Man

More contributors: Carolyn Beasley, Tamara Dean, Amanda Freeman, Don Fuchs, Liz Ginis, Bridgette Gower, Tiffany Klein, Danah Leary, Holly Matheson, Mandy McKeesick, Fiona McMillan-Webster, Lee Mylne, Scott Portelli, Hugh Possingham, Sarah Reid, Damien Siviero, Jasmine Vink, Duncan Wright

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YOUR SAY

Vietnam's scars

$50 WINNER

FEATURED LETTER

When I was 20, my younger brother won a prize in the birthday lottery (*War's Lingering Shadow*, AG 185). Previously he had applied to join the Navy, but was rejected because of his poor eyesight. Total hypocrisy by the Australian Government of the day, my brother was considered unfit to serve on a ship but was drafted to serve on the frontline in Vietnam as cannon fodder. It's a lie that all those who were sent to Vietnam were volunteers – they were not. The Nashos were sent there because it cost the government less to use them than to use regular soldiers. Political bastardry!

My brother lost his girlfriend while he was in Vietnam – she married the other bloke – and my brother never married. Like most Vietnam vets, he didn't talk much about his time there, but he told Mum and she told me some of it. Once in a sweep across a paddock the lad next in line to him was killed by a landmine, and later he served as a tunnel rat. Hardly surprising that he came home with PTSD.

It wasn't obvious at first. He returned to his trade and seemed to be okay for a few years until an economic setback knocked him out, and for years after that he lived in a caravan, surviving by doing odd jobs. The Army didn't want to know about his problems – he had to fight for years to get recognition that he had PTSD as a result of his service. Eventually he was granted a service pension. He now has a house of his own and is living relatively comfortably, but Vietnam radically altered his life, and definitely not for the better. Many, probably most, Vietnam vets had similar experiences, both in Vietnam and in being discarded and disregarded by the Army and government after coming home.

That war was inexcusable, entirely a result of US anti-communist paranoia, but it was our government's fault that we were caught up in it, not the fault of the men who were drafted to fight it at minimum cost to the government. Ordinary people suffer when a government is focused on cost cutting. The next time there is conscription, the first people to be drafted should be the politicians in the party in power and those who voted for it.

Peter Schaper, Biggenden, QLD

BOLTING FROM THE SCENE

War's Lingering Shadow (AG 185) reminded me of a possibly amusing story I heard in the late 1970s, when I was a trainee laboratory technician at Sydney University. During this time, conscription had gone but was still well remembered, and a great story was told to me about a big pair of bolt cutters we had in the chemistry lab.

A high-profile draft resister was in a car close to Sydney University when police entered the car and handcuffed him. They had 'their man' but not the car, the driver of which made a sharp turn into the university campus. A crowd of students quickly formed around them. A student sprinted to the chemistry building to convince the lab staff to release the bolt cutters, and when he returned the crowd opened to allow the bolt cutters in. In a moment the handcuffs were gone and the draftee disappeared into the crowd. The crowd wouldn't allow the police in. The police had to leave the university and explain how 'their man' got away.

A great tale but it happened nearly 50 years ago, so it would be better if the original high-profile conscription resister could tell their side of the story.

Keith Maxwell, Seven Hills, NSW

OCTOPUS AWE

I used to think of octopuses as strange and scary things, maybe due to childhood stories of giant creatures with poisonous suckers. Some years ago, after realising what smart and sentient beings they and their squid cousins are, I stopped eating calamari.

The article *Serious Sea Smarts* (AG 184) and its amazing photos has increased my respect and awe for these underwater wonders. The research about their ability to change their RNA is indeed extraordinary. Does this mean they will be better adapted to changing sea temperatures? And does this apply to squid as well, who are apparently thriving in warmer water?

Having finally faced my fears of the underwater world in my sixth decade, I have just learnt to snorkel. Besides all the other delights awaiting me, I hope that one day I will be able to see an octopus in its real home.

Ilse van Staden, Lake Munmorah, NSW

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BUNYA ABUNDANCE

The arrival of AG 185 and its *Bunya Nut Boom* story corresponded with the dropping of the 18th cone from my backyard bunya pine, planted in 1987. It certainly was a mast fruiting this year. Average cone size was 1.7kg. Every feature of this native tree appeals, from its prehistoric form and protein-rich bush food to the names ascribed to it by the first custodians.

Dr Gary Bacon AM, Ferny Grove, QLD

EMPTY NESTERS

I enjoyed the story on the bush-stone curlew in AG 185. For about four years we have had a pair of curlews nesting in our yard. It is the same pair, I think. Eight chicks have grown up in our yard. We have other wildlife in the yard, including brushtail possums with young.

Michael Crossley, Wellington Point, QLD

SETTING THE RECORD STRAIGHT

I was amused and a little saddened to read Kel Richards' scepticism at the possibility of cormorants being found "that far inland" as Yarrawonga (Geobits, AG 185). Cormorants are waterbirds, not shorebirds. I've seen them at alpine lakes, irrigation canals on the Hay Plains, at Lake Eyre and at all the big northern and western rivers, including Nitmiluk (Katherine River). Give them water and fish to hunt, and they will be there.

Lyndsey Evans, Primrose Sands, TAS

HOSPITAL HICCUPS

The political turbulence that accompanied the Rum Hospital's construction (Defining Moments, AG 185) continued in 1878 when the decision was made to build a new "Sydney Infirmary and Dispensary" for a guaranteed maximum cost of £45,000. Architect Thomas Rowe (of Strand Arcade fame) submitted a design for a four-storey building, which a major builder approved. Work began July 1881. Rowe later claimed the building needed to be at least five to six storeys to accommodate the brief, so the committee agreed to increase the hospital's bed numbers from 180 beds to 264 without requesting (Rowe later claimed) a revised construction estimate. The government ordered work be stopped when costs reached £63,923, with an estimated additional £140,000 needed to complete it. Work ceased for 10 years with claim and counterclaim. (Rowe was accused of wanting his "head carved in stone over the entry"!) He was replaced by John Kirkpatrick (who was the subject of my Architectural Thesis). The building was completed in 1894, costing an additional £53,000. The Sydney Opera House saga is reminiscent of the history of Sydney Hospital. Allow progress to continue unchecked, find someone to blame! Both great buildings worked out well in the end.

Stephen Malone, Turramurra, NSW

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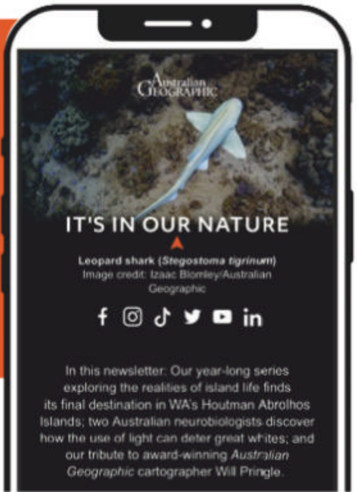


IT'S IN OUR NATURE

Leopard shark (*Stegostoma tigrinum*)
Image credit: Izaac Blomley/Australian Geographic

In this newsletter: Our year-long series exploring the realities of island life finds its final destination in WA's Houtman Abrolhos Islands; two Australian neurobiologists discover how the use of light can deter great whites; and our tribute to award-winning *Australian Geographic* cartographer Will Pringle.

TALKB@CK

Did you know Victoria's Yarra River (Birrarung) has legal status as a living entity? On the International Day of Action for Rivers, our audience discussed the legal rights of rivers.

HERE'S WHAT YOU HAD TO SAY:

Britt Webster
Rivers keep us alive. It makes sense to have every protection placed upon them to sustain healthy [wild]life.

Tom Doyle
Absolutely ridiculous. Who decides the guardians? Governments are elected for this exact purpose to manage the land.

Seán Marsh
Human exceptionalism tricks us into thinking we're the only beings on this planet with intelligence, sentience, and a right to exist.

Owen Wylde
Would a river be convicted of murder or manslaughter next time someone drowns in it?

Clara Cleave
All living things should have rights and be shown respect. A good start.

Vanessa Wright
Fab idea, forests should hold the same rights. Takayna in Tasmania, for example!

Chris Mitch
Every lifeform needs to consume another lifeform to stay alive itself. All life should be allowed that right (to live). Without nature, without rivers, without life...nothing would survive. Why do humans only value something legally, if it can be bought or sold or someone can devalue it to make a personal profit. All non-human life should have equal rights to a decent, worthwhile, equal existence.

PHOTO CREDITS, FROM LEFT: DR GARY BACON; SHUTTERSTOCK

GEOBUZZ

MAY – JUNE 2025

HOLLOW WOOD STAR

STANDING ON THE edge of the footpath on a suburban Canberra street chatting to passers-by isn't normally the way people think bird photography happens. Researchers gave me the location of a gang-gang cockatoo (*Callocephalon fimbriatum*) nest and I spent a few hours waiting and watching a pair come and go from the site, which was located right next to the road.

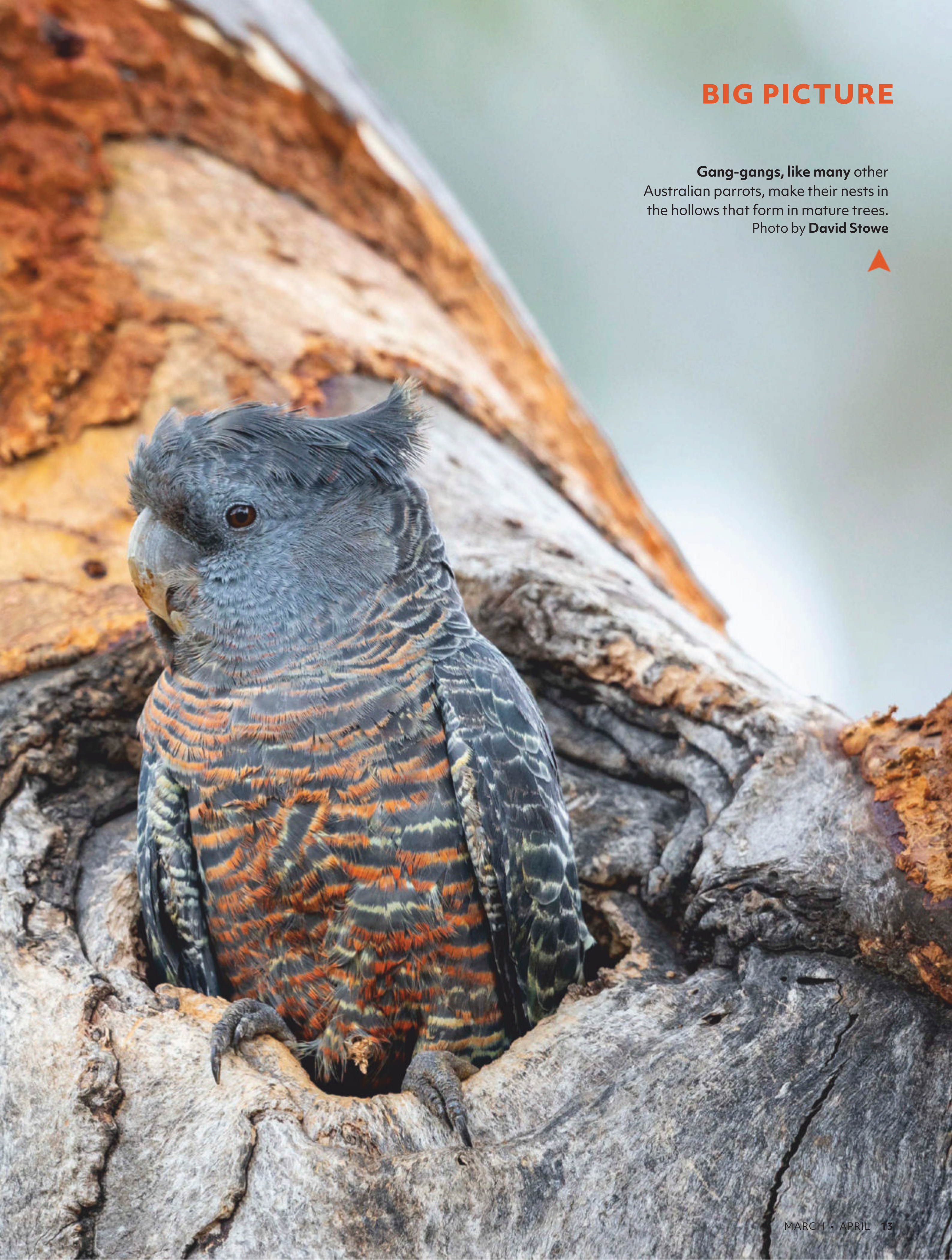
Gang-gangs keep a hollow open by chewing the wood around it to stop it from healing and closing up. Here, in this moment, the chewed tree rings resemble the colouring around the bird's own neck – creating a special composition.

I know many people have a strict belief that you shouldn't photograph nests at all. I take a pragmatic approach while keeping the bird's interests central. The gang-gang is fairly gregarious and not particularly timid – which is obviously not applicable to all bird species. Standing nearby on a footpath with many people walking past at the base of the tree, I observed their behaviour and at no point did they seem agitated.

As well as being able to capture some close and intimate images, it was really special chatting to locals walking past. Seeing their joy and being able to share the experience is surely what nature loving and conservation is all about.

David Stowe

BIG PICTURE



Gang-gangs, like many other Australian parrots, make their nests in the hollows that form in mature trees. Photo by **David Stowe**

GEOBITS

EDITED BY **ESME MATHIS**

Rainbow lorikeets still rule the roost

The rainbow lorikeet was the most-counted bird in the Aussie Bird Count.

Citizen scientists counted more than 4.1 million birds during the 2024 Aussie Bird Count, providing invaluable data for BirdLife Australia to better understand avian biodiversity across the nation. The results are now in!

The rainbow lorikeet has topped the nationwide list for the 11th year in a row. This colourful parrot was the most-counted bird in New South Wales, South Australia, Victoria, Western Australia and Queensland.

In second place came the noisy miner. This small (and highly territorial) native honeyeater was the second-most counted bird in NSW and QLD, and the third most-counted bird in SA and VIC.

The Australian magpie placed third, followed by the sulphur-crested cockatoo, welcome swallow, galah, silver gull, Australian white ibis, house sparrow and little corella.

Other notable species include the crimson rosella, magpie goose, New Holland honeyeater, common blackbird and Torresian crow.

Stay tuned for the 2025 Aussie Bird Count, which will take place from 20–26 October 2025. In the meantime, you can contribute bird surveys to BirdLife Australia's free Birdata platform.

For more information *birdata.birdlife.org.au*

World's oldest impact crater found in the Pilbara

These distinctive geological formations called shatter cones are a telltale sign of a meteor impact.

Scientists from Curtin University have found the world's oldest-known meteorite impact crater in Western Australia. The researchers were studying rock layers of the North Pole Dome, in the Pilbara region, when they discovered shatter cones – unique rock formations created by the shock wave of a meteor strike. The findings, published in *Nature Communications*, revealed the crater is 3.5 billion years old.

The discovery raises interesting questions about earth's early history. "Uncovering this impact and finding more from the same time period could explain a lot about how life may have got started, as impact craters created environments friendly to microbial life such as hot water pools," said co-lead author Professor Chris Kirkland, from Curtin's School of Earth and Planetary Sciences.

"It also radically refines our understanding of crust formation: the tremendous amount of energy from this impact could have played a role in shaping early earth's crust… It may have even contributed to the formation of cratons, which are large, stable landmasses that became the foundation of continents."

PHOTO CREDITS, FROM TOP: SHUTTERSTOCK; TIM JOHNSON, CURTIN UNIVERSITY

The toxic sex life of the blue-lined octopus

Male blue-lined octopuses use venom to avoid becoming a victim of sexual cannibalism.

Scientists from The University of Queensland (UQ) have discovered that male blue-lined octopuses (*Hapalochlaena fasciata*) inject females with venom to paralyse them before mating – and avoid being eaten after sex.

The blue-lined octopus is one of several blue-ringed octopus species endemic to Australia's east coast. Both male and female blue-lined octopuses produce a powerful neurotoxin called tetrodotoxin (TTX), used for hunting prey and as a defence against predators. But new research, led by Dr Wen-Sung Chung from UQ's School of the Environment and published in *Current Biology*, has revealed that males also use TTX to immobilise females while mating, reducing the chance of being eaten afterwards.

During copulation, a male latches onto a female from behind and bites into her aorta, injecting her with TTX venom. The female then enters an asphyxia-like state; her pupils shrink and her skin turns pale, losing its colouration. Copulation typically lasts an hour, until the female regains her muscle control and shoves the male off. The female has a vested interest in eating the male after sex; she needs to hoard calories before her weeks-long fast while guarding her clutch of eggs.

This behaviour may explain why the venom gland in the male blue-lined octopus is about three times the size of the female's.

Rooproductive technologies

Also at The University of Queensland (UQ), scientists have created the world's first kangaroo embryo through in-vitro fertilisation (IVF). The scientists made the eastern grey kangaroo embryo by injecting a single sperm into an egg, a specialised IVF technique known as intracytoplasmic sperm injection. It's hoped this technology might one day offer a lifeline to threatened marsupial species across Australia.

"Our ultimate goal is to support the preservation of endangered marsupial species like koalas, Tasmanian devils, northern hairy-nosed wombats and Leadbeater's possums," said lead researcher Dr Andrés Gambini from UQ's School of Agriculture and Food Sustainability.

Dr Gambini said a live birth of a marsupial through IVF might still be a decade away. The research was published in *Reproduction, Fertility and Development*.

Scientists have made a kangaroo embryo through IVF.

Tool use was observed in several wrasse species of the *Halichoeres* genus.

Spotted: tool-wielding wrasses

Macquarie University scientists working in the Atlantic Ocean have documented five wrasse species of the *Halichoeres* genus using 'tools'. The colourful fish were observed picking up shellfish such as crabs and molluscs and smashing them on hard surfaces, dubbed 'anvils', to crack the prey's exoskeleton and access the meat inside.

"Tool use is typically associated with humans, but this behaviour is proof that fish are far cleverer than they get credit for," said Dr Juliette Tariel-Adam from Macquarie University's School of Natural Sciences. "With these newly discovered tool-using species, it becomes clear many species of wrasse use tools that we previously didn't know about. There are over 600 species of wrasse all around the world, and we're still far from knowing how many of them use tools. It's only through collective efforts [from citizen scientists] that we can uncover these hidden behaviours in marine life."

The research was published in *Coral Reefs*.

For more information: *fishtooluse.com*

PHOTO CREDITS, FROM TOP: WEN-SUNG CHUNG; COURTESY THE UNIVERSITY OF QUEENSLAND; COURTESY MACQUARIE UNIVERSITY

Telescopes in Western Australia can detect fast radio bursts, which last just a few milliseconds.

Astronomers tune in to fast radio bursts

CSIRO engineers and astronomers have developed a new technology that enables the ASKAP radio telescope in Western Australia to better detect fast radio bursts.

Fast radio bursts are energetic but fleeting explosions of light from outside our galaxy. These mysterious radio signals were first discovered in 2007 by astronomers at the Parkes radio telescope in New South Wales, prompting a new field of research in astronomy.

Now, CSIRO's new technology (named CRACO) will help scientists better understand this mysterious space phenomenon by scanning trillions of pixels generated by the telescope and alerting scientists when it spots anomalies.

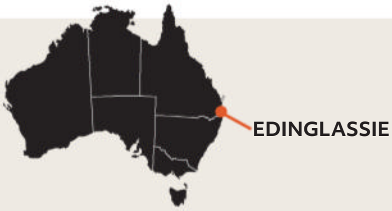
"CRACO taps into ASKAP's 'live' view of the sky in search of fast radio bursts," said CSIRO astronomer and engineer Dr Keith Bannister. "To do this, it scans through huge volumes of data – processing 100 billion pixels per second – to detect and identify the location of bursts. That's the equivalent of sifting through a whole beach of sand to look for a single 5c coin every minute."

The first trial of this technology, conducted by Curtin University researchers at the International Centre for Radio Astronomy, surpassed expectations by detecting more than 20 fast radio bursts.

The technology will soon be available to astronomers across the globe at CSIRO's Australia Telescope National Facility.

PLACENAMES

By Kel Richards



EDINGLASSIE

THIS IS NOT a name you'll find on any map of Australia – but it almost got there. In Defining Moments in AG 184 you would have read about the founding of Brisbane, which was originally called the Moreton Bay Penal Settlement. On 9 November 1824 Chief Justice Sir Francis Forbes suggested calling the place Edinglassie, after his family's ancestral estate in Scotland. However, the place was named Brisbane after Sir Thomas Brisbane, Governor of New South Wales from 1821 to 1825. These days we love to nickname the city 'Brissie' or 'Brisvegas'. (Somehow Edinglassie doesn't have quite the same ring, does it?) And the First Nations name, of course, is Meanjin – so, one city with (almost) five names!

OZ DIARY

VIC

SOAK UP HERITAGE

History comes to life each May during the Ballarat Heritage Festival, bringing history and chic retro vibes to this vibrant regional town from 16–25 May. The festival's jam-packed itinerary includes an antique fair at the Art Deco Ballarat Civic Hall, the Ballarat Beard and Stache Competition, craft displays at Craft Lab 24, and various live entertainment, tours and shows.

MORE INFO:
ballaratheritagefestival.com.au

NT

CELEBRATE CULTURE

The Barunga Festival returns 6–9 June for another incredible festival near Katherine. The festival's itinerary is a mix of First Nations culture, music and sport. Its traditional cultural program offers audiences the chance to learn more about Dreamtime storytelling, bush medicine and cooking, and even to try their hand at spear throwing, traditional dance, and making and playing the didgeridoo.

MORE INFO:
barungafestival.com.au

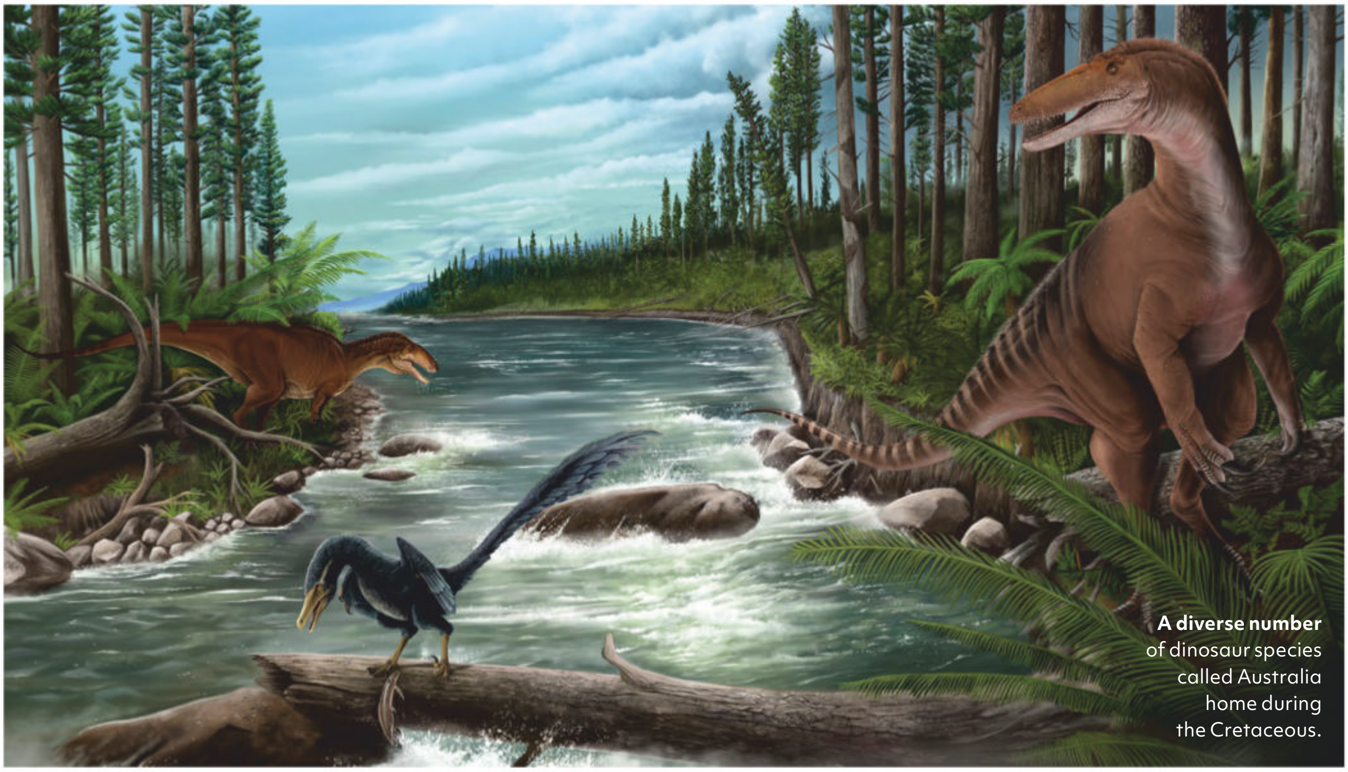
NATIONWIDE

NATIONAL RECONCILIATION WEEK

The theme for this year's National Reconciliation Week (27 May–3 June) is Bridging Now to Next, reflecting "the ongoing connection between past, present and future". It urges us to "look ahead and continue to push forward as past lessons guide us".

MORE INFO:
reconciliation.org.au

PHOTO CREDITS, FROM LEFT: ALEX CHERNEY/CSIRO; COURTESY CITY OF BALLARAT



A diverse number of dinosaur species called Australia home during the Cretaceous.

Meet Australia's 'newest' dinosaurs

Palaeontologists from Monash University and Museums Victoria Research Institute have discovered Australia's first carcharodontosaur fossils. The fossils were excavated in 2022 and 2023 near the Bass and Otway coasts in southern Victoria and are between 122 and 108 million years old.

These large carnivorous theropods – whose name literally translates to 'shark-toothed lizards' – were fearsome apex predators in African and South American ecosystems during the mid-Cretaceous, reaching lengths of up to 13m. The newly discovered fossils reveal their Australian counterparts were much smaller (about 2–4m long).

Palaeontologists also excavated the world's oldest known megaraptorid specimens. Megaraptorids were medium-sized theropod carnivores that had elongated snouts, small teeth and curved, scythe-like claws. They were one of the largest known apex dinosaurs in Australia.

The research, led by Museums Victoria Research Institute and Monash University PhD candidate Jake Kotevski, was published in the *Journal of Vertebrate Paleontology*.

"The discovery of *Carcharodontosaurus* in Australia is groundbreaking," Kotevski said. "It's fascinating to see how Victoria's predator hierarchy diverged from South America, where *Carcharodontosaurus* reached *Tyrannosaurus rex*-like sizes up to 13m, towering over megaraptorids. Here, the roles were reversed, highlighting the uniqueness of Australia's Cretaceous ecosystem."

Federal threatened species list updated

A further 21 native flora and fauna species have recently been added to Australia's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) threatened species list. The newly added species include the little tern (*Sternula albifrons*), the Australian humpback dolphin (*Sousa sahulensis*), Irwin's turtle (*Elseya irwini*), Murray crayfish (*Euastacus armatus*) and Ettrema mallee (*Eucalyptus sturgissiana*). Six plant species already on the list were moved into higher-threat categories.

The EPBC Act's threatened species list is the national register of the conservation status of Australian wildlife and ecological communities. Threatened fauna and flora are listed under the following categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, conservation dependent.

The Murray crayfish has entered Australia's threatened species list.

PHOTO CREDITS, FROM TOP: JONATHAN METZGER/MUSEUMS VICTORIA; SHUTTERSTOCK

SNAPSHOT

Gillard's legacy

Fifteen years after she came into office it's clear Julia Gillard, Australia's first female prime minister, has left an indelible mark.

ELECTED UNOPPOSED AS Labor party leader after Kevin Rudd's resignation, Julia Gillard was sworn in as the 27th prime minister of Australia on 24 June 2010. In doing so she became Australia's first female prime minister, and her impact as leader endures today.

The most famous moment of Gillard's prime ministership occurred on 9 October 2012 when she delivered her powerful 'misogyny speech' in Parliament. Opposition leader, Tony Abbott, had accused her of hypocrisy and sexism as she defended house speaker, Peter Slipper – himself implicated in a misogynistic text scandal – during a motion for his removal. Gillard addressed the topic head-on. "I will not be lectured about sexism and misogyny by this man. I will not," she began, later stating, "If he wants to know what misogyny looks like in modern Australia, he doesn't need a motion in the House of Representatives. He needs a mirror."

At home, the reaction to Gillard's speech was mixed. Critics pointed to its context, ostensibly in support of Slipper, and painted her as being hypocritical and politically expedient. But beyond Australia, the speech garnered worldwide attention and continues to do so today. On the back of the #MeToo movement and the experience of Hillary Clinton in the 2016 US election – Gillard and Clinton are good friends and have since worked together extensively – the speech took on a life of its own. Today it continues to circulate on TikTok, resonating with a generation barely in school at the time it was delivered.

But to focus only on the speech is to ignore her many achievements in office. So too does focusing on what was, at the time, her most controversial policy: a carbon pricing scheme, often referred to as the 'carbon tax', which led to accusations of broken pre-election commitments and earned her the derisive nickname 'Juliar' throughout her leadership. The tax was repealed by the subsequent government.

Indeed, Gillard achieved major social reforms. The establishment of the National Disability Insurance Scheme (NDIS) stands as one of her most enduring legacies and today supports some 690,000 Australians with disabilities. She oversaw the implementation of paid parental leave, which came into effect on 1 January 2011. She initiated the Royal Commission into Institutional Responses to Child Sexual Abuse, which earned her significant praise when its findings later proved to be so damning.

In 2013, in a full-circle moment, she was ousted for Kevin Rudd. In her farewell speech, Gillard called for Australians to reflect on the role gender had played on her time in office. "It doesn't explain everything. It doesn't explain nothing. It explains some things," she said. "And it is for the nation to think – in a sophisticated way – about those shades of grey."

Julia Gillard was sworn in as prime minister of Australia on 24 June 2010 after a leadership spill. Governor-General Quentin Bryce then swore in Gillard's ministry on 14 September 2010. Gillard is pictured here during the September ceremony.

Photo credit: Alan Porritt-Pool/Getty Images

TIM THE YOWIE MAN

Outback UFOs

WYCLIFFE WELL IS a tiny speck off the Stuart Highway in the middle of the Northern Territory, about 130km south of Tennant Creek. The former roadhouse was named after the site of a water well sunk in 1875 for workers on the Overland Telegraph Line.

During World War II a market garden was established near the old well to supply troops travelling to and from Darwin, and army transport driver Viv Martin spotted “a small silver craft hovering over a group of Australian soldiers” at the “nearby” Karlu Karlu/Devils Marbles. (In outback parlance 25km is considered to be nearby.)

“Dad stopped on a nearby hill to take a photo,” says Viv’s son Phil. But by the time he got there, the two flying saucers – which he describes as each being “the size of a football field” – had vanished. “The soldiers took off after the UFOs, but their tyres were shredded by tree roots,” Phil says. “They spent hours and hours looking for them, but they couldn’t find them.”

Phil still treasures the photo taken by his late dad. After the war, as more motorists travelled along the Stuart Highway, the area’s reputation as a UFO hotspot grew and grew. A roadhouse popped up, soon complemented by a holiday park and complete with accommodation.

But it was only after Lew Farkas bought the roadhouse in 1985 and transformed the run-down pit stop into the UFO Capital of Australia (complete with landing pads and alien-inspired menu items) that Wycliffe Well gained international notoriety.

Lew installed a UFO landing pad outside, while inside the walls of the roadhouse were plastered with newspaper and magazine clippings of UFO sightings.

Lew claimed it was all based on fact. Indeed, in the 1990s, Lew told me that “the previous owner kept UFOs secret to ensure prospective buyers didn’t get spooked”.

Lured by the prospect of capturing evidence of those ultra-elusive little green men, extraterrestrial enthusiasts from across the globe converged on the tiny outback outpost. Some even celebrated it as one of the top five places in the world to spot a UFO. Really!

Comparisons were drawn to Roswell in the United States, with some ufologists arguing the Wycliffe Well area’s high level of UFO activity was related to top-secret military presence in the outback – including the Pine Gap intelligence-gathering facility, about 20km south-west of Alice Springs.

In late December 2022 a catastrophic flash flood swept through the area, destroying the roadhouse – sad news for aliens and earthlings alike. Since the roadhouse was abandoned, the number of reported UFO sightings has dropped.

WELCOME TO WYCLIFFE WELL
UFO CAPITAL OF AUSTRALIA

Once a world-famous UFO hotspot, Wycliffe Well was abandoned in 2022 after a flash flood.

Perhaps the aliens are deterred by the unkempt state of the bathrooms (still labelled as being for Maliens and Femaliens), their partly smashed-up landing pad, or the decapitated state of the alien mannequins?

Of course, it could also be because fewer travellers are stopping there, their imaginations no longer stimulated by a smorgasbord of alien paraphernalia after a long and lonely drive through the outback.

Whatever your take on UFOs, Wycliffe Well Roadhouse was an outback landmark and is missed by many – not least, it seems, by those little green folk from outer space.

TIM, a naturalist, author, broadcaster and tour guide, has dedicated more than 30 years to documenting unusual natural phenomena in Australia. His books include *Haunted and Mysterious Australia* (New Holland, 2018). Follow him on Facebook and X @TimYowie

UNSOLVED

In our new Great Aussie Mysteries *video series, Tim delves into the nation’s most inexplicable events.*

Melbourne UFO sightings
On 6 April 1966 more than 200 students from Westall High School looked up to see a flying object in the sky. What did they really see?

Do Tassie tigers still exist?
The thylacine was officially declared extinct in 1986 – but is there a chance they still roam the wilderness?

The case of the vanishing PM
On an ill-fated day in 1967, Prime Minister Harold Holt disappeared below the waves of Cheviot Beach and was never seen again. What theories surround his disappearance?

Bogle–Chandler deaths
On 1 January 1963 two lovers were found dead next to Lane Cove River in suburban Sydney. Were they murdered? Or was something else afoot?

Australia’s El Dorado
Lasseter’s Reef is supposedly hidden somewhere west of the MacDonnell Ranges in Central Australia. Does this dazzling quartz reef filled with flecks of gold really exist?

Min Min lights
The mysterious Min Min lights have long astounded outback tourists and residents. Witnesses say this lighting phenomenon retreats when approached. Is there a scientific explanation?

LEARN MORE

Scan the QR code for more fromour *Great Aussie Mysteries* with Tim the Yowie Man.
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JOURNEY BEYOND

TREADING LIGHTLY

WITH ROGER SMITH

An olive python basks in the sun at Alice Springs Reptile Centre in the Northern Territory.

Solving snake stigma

Let's extend an olive branch to Australia's most often misunderstood reptiles and correct misconceptions about them.

IT'S NIGHT AND I'm anxious. In front of me, on a remote highway in Australia's tropical Top End, the woman I love is using a towel to scare off a giant snake. Sitting in the driver's seat of our stationary car, my job is to keep the headlights on the olive python (*Liasis olivaceus*) that's stretched out on the tarmac beside my life partner.

Janine (the brave woman) moves closer, gently waving the towel, attempting to convince the huge snake to move off the highway so it won't be run over. It's about 3.7m long – half the width of the road – and has a body as thick as my calf. It probably weighs about 50kg. This is not an animal we'd normally try to intimidate.

The snake raises its large head a metre off the road, turns towards Janine and hisses loudly. It then drops back onto the tarmac and slithers into the bush, its sinuous body gleaming beautifully in the headlights.

Adrenaline pumping, Janine climbs back in the car and we take stock of what just happened. We know snakes often lie on roads. Being cold-blooded, they absorb warmth from road surfaces to keep their metabolism at an optimal level. Sadly this means that many snakes, especially pythons, end their lives as roadkill. We've even seen drivers purposely swerve to hit them.

But why are humans terrified of snakes? It's irrational to assign so much fear and loathing to animals without legs, arms, wings or claws, and that can only slither around.

When I was a child I was told "the only good snake is a dead one". I was disgusted every time someone proudly displayed a mutilated snake they'd destroyed for no good reason! As a wildlife guide who has led tours across Australia for 30 years, I've seen hundreds of snakes, both venomous and non-venomous. Not one has ever threatened me. In fact, they usually move away as fast as possible.

Snakes never attack without provocation. And why would they? They don't see humans as food. But they'll defend themselves if they're cornered, antagonised or injured, and they only have one way to do that: with their mouth.

Across Australia (and the world), snake species are declining. In the Top End, many snakes die as a result of eating poisonous cane toads. And snakes everywhere are suffering due to introduced foxes and cats, loss of prey caused by large-scale land clearing, urban development, drying waterways (due to climate change) and, increasingly, vehicle strikes.

So, be nice to snakes. And watch out for them on the road.

ROGER SMITH has a long background in nature conservation, citizen science, wildlife tourism and energy-efficient housing. Now, as Director of Conservation Travel at Australian Geographic Travel, his role is to oversee citizen science activities, implement a climate-action plan and help expand the Conservation Travel portfolio.

PHOTO CREDIT: ALAMY

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DEFINING MOMENTS
IN AUSTRALIAN HISTORY

The ongoing campaign to abolish nuclear weapons

2017 Nobel Peace Prize won by Melbourne-founded nuclear disarmament organisation

IN THE LATE 1960s, as the Cold War nuclear arms race gained momentum across the globe, the United Nations penned an international treaty to address the looming threat of global nuclear annihilation. Opened for signature in July 1968, the Treaty on the Non-Proliferation of Nuclear Weapons aimed to prevent the spread of nuclear weapons and promote peaceful cooperation in the use of nuclear energy. It came into force in 1970 and was extended indefinitely on 11 May 1995.

More than 190 countries signed the pact, including five nations with nuclear weapons – the United States, the Soviet Union, the United Kingdom, France and China. But the agreement sought to reduce the spread of nuclear weapons, not abolish them. And anti-nuclear activists in Australia and across the globe wanted a more hardline stance against weapons of mass destruction.

"We need a determined worldwide movement to outlaw and abolish nukes," Geelong-born GP Dr Bill Williams, co-founder of the International Campaign to Abolish Nuclear Weapons (ICAN), said in 2006. "To get there in this generation, we need to build the wave of public opinion into a mighty crescendo: a massive, surging, irresistible force which carries us all the way to absolutely zero nukes. Without it, even the most inspirational of leaders will falter on the way."

The concept for ICAN was first proposed by Dr Ron McCoy, a Melbourne-based obstetrician and former co-president of International Physicians for the Prevention of Nuclear War (IPPNW). He initially suggested the idea through the IPPNW network. In 2006, during its 17th world congress in Helsinki, Finland, the IPPNW adopted ICAN as a priority action.

By 2007 ICAN had set up its first office in Melbourne. It soon developed into a coalition of diverse partner organisations around the world, all working towards a clear objective: a comprehensive, binding treaty to prohibit nuclear weapons and ultimately eliminate them. To achieve its goal, ICAN needed to have global reach, engage young people, and firmly advocate for the unacceptability of nuclear weapons. In 2011 ICAN opened new headquarters in Geneva, Switzerland, and began building its international workforce. ICAN is now a coalition made up of NGOs from more than 100 countries.

In 2016 it successfully advocated for a special UN working group on nuclear disarmament and campaigned for the UN General Assembly's resolution to undertake negotiations on a treaty for the purpose of banning nuclear weapons. The subsequent Treaty on the Prohibition of Nuclear Weapons was driven by a growing sense of frustration over inaction on nuclear disarmament. ICAN was an active participant in the treaty negotiations process.

The treaty called for the total elimination of nuclear weapons, prohibiting nations from developing, testing, building, manufacturing, transferring, owning and stockpiling nuclear weapons. It has been argued that these strict demands polarised the international community. All nuclear-armed countries and many of their allies – including Australia – have not signed the treaty, which opened for signature on 20 September 2017 and came into force on 22 January 2021. To date, it has been ratified by 73 nations.

In 2017 ICAN received the Nobel Peace Prize for "its work to draw attention to the catastrophic humanitarian consequences of any use of nuclear weapons and for its ground-breaking efforts to achieve a treaty-based prohibition of such weapons".

At the ceremony, held on 10 December 2017 at Oslo City Hall in Norway, ICAN's executive director, Beatrice Fihn, accepted the award on behalf of the organisation.

ICAN executive director Beatrice Fihn (right) celebrates after accepting the Nobel Peace Prize on behalf of ICAN. She's standing beside anti-nuclear campaigner and Hiroshima bombing survivor Setsuko Thurlow.

"We are a movement for rationality. For democracy. For freedom from fear," Beatrice said. "We are campaigners from 468 organisations who are working to safeguard the future, and we are representative of the moral majority: the billions of people who choose life over death, who together will see the end of nuclear weapons."

ICAN's receipt of the Nobel Peace Prize demonstrates, among other things, the influence of Australians in the international disarmament movement.

Today, ICAN is still active. The organisation continues to strive to enforce the Treaty on the Prohibition of Nuclear Weapons, working with its 652 partner organisations across the globe.

ICAN's Australian office advocates for Australia to sign and ratify the Treaty on the Prohibition of Nuclear Weapons. It works with more than 70 partner organisations across Australia to continue building community support for nuclear disarmament.

national museum australia

Part of the Defining Moments in Australian History project
TO FIND OUT MORE: *nma.gov.au/defining-moments*

PHOTO CREDIT: GETTY IMAGES

NEED TO KNOW

WITH DR KARL KRUSZELNICKI

The truth about cat and dog years

It's a dog's life! Dogs age at different rates based on their size. This senior pug is in its autumn years but has outlived larger breeds such as Great Danes or Saint Bernards.

THE IDEA BEHIND 'pet years' is to have a simple way to compare the life stages of our pets to human life spans. The standard understanding is that one pet year equals seven human years. However, the reality is much more complex. After all, most one-year-old pets can make babies – but seven-year-old humans cannot.

There are three main factors that affect the maximum life span of an animal. First is intelligence: the 'smarter' the animal, the better it can adapt to its environment and survive. The second relates to environmental hazards: most animals in the wild are killed by predators, disease or injuries well before they begin losing performance as a result of ageing. And the third factor is nutrition: too much or too little food will shorten an animal's life span.

Cats and small dogs age at a similar rate in 'pet years', but large dogs age much faster because they have shorter life spans. For example, a 10-year-old Great Dane will have a similar age in pet years to a 15-year-old chihuahua. Dogs age rapidly in the first two years of life, and then the rate slows down. As a general guide, a dog will age about 10–15 human years in the first year, and about nine in the second.

Once a dog turns two, each following year is equivalent to about four or five human years (small-sized dogs), five or six human years (medium-sized dogs) and six or seven years (large dog breeds).

Cats age at a similar rate to small dogs – about 15 human years in the first year of life and about nine in the second. But each following year equals four human years.

Cats and dogs have shorter life spans than humans because their organs, metabolism and cellular structures have evolved for quicker development, maturity and ageing.

However, for both cats and dogs, the simple 'one calendar year equals seven pet years' is definitely wrong. Many 12-year-old cats can jump tall fences and chase other cats. But you don't see similar behaviour in most 84-year-old humans.

DR KARL is a prolific broadcaster, author and Julius Sumner Miller fellow in the School of Physics at The University of Sydney. His latest books are *Dr Karl's Little Book of Climate Change Science* and *A Periodic Tale: My Sciencey Memoir*, published by HarperCollins Publishers Australia. Follow him on X @DoctorKarl and TikTok @DrKarl. **More info:** *drkarl.com*

PHOTO CREDIT: ALAMY

OZ WORDS

By Kel Richards

GOT A QUESTION ABOUT AUSSIE ENGLISH?
Contact Kel at:
ozwords.com.au

NO WORRIES

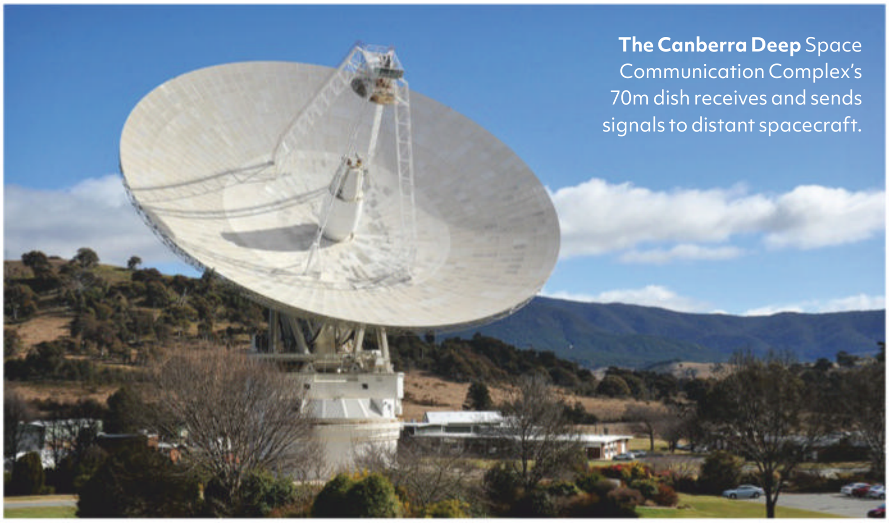
I'VE BEEN ASKED to track down that very Aussie expression 'no worries'. (It somehow encapsulates the Aussie character, doesn't it?)

'No worries' first appeared in print in 1965 in the satirical magazine *Oz* but was almost certainly part of the spoken language for years before that. It appears to be a variation of the earlier expression 'no sweat'. That one began as American army slang in 1951 during the Korean War. Aussie diggers fighting alongside US soldiers heard the phrase and took it home. Here it turned into the laconic, easygoing Aussie version of 'no worries', which to me is so perfectly Australian, conveying a relaxed, tackle-anything approach to life and one that often involves improvising with whatever is at hand.

In World War I, a British general who'd served with our troops famously said: "If the world blew apart tonight, two Aussies would have it back together again by tomorrow morning with a bit of baling wire." (On that note, don't miss Part 1 of our Regional Innovations series on page 78.)

SPACE

Celebrating Tidbinbilla



The Canberra Deep Space Communication Complex's 70m dish receives and sends signals to distant spacecraft.

I'M OFTEN ASKED about the space probes that are leaving the solar system, never to return. There are five of them: *Pioneer 10* and *11* and *Voyager 1* and *2* – all launched in the 1970s – and *New Horizons*, which began its journey to Pluto and beyond in 2006.

These tokens of humanity are extraordinary because they'll probably outlast the species that created them, and perhaps even our planet. Space is so empty they could travel billions of years unimpeded by a collision or capture into orbit around another star.

All these missions were outstandingly successful in their quest to explore the solar system's outer reaches, and all but the two Pioneers still actively communicate with Earth. Their signals are received and transmitted via NASA's Deep Space Network (DSN), along with those for the many other interplanetary missions the space agency supports.

Cleverly, the DSN consists of three ground stations separated almost equally in longitude to maximise the likelihood of any given spacecraft being visible from at least one of them. They're located in California, in Spain, and at Tidbinbilla in the Australian Capital Territory.

Formally known as the Canberra Deep Space Communication Complex, the Tidbinbilla facility is managed by CSIRO for NASA and has a particularly important role in the DSN's operations. Its dish is the only facility on Earth capable of communicating with *Voyager 2* as it leaves the solar system at a speed of 15 kilometres per second (km/s).

The craft isn't the fastest or the most distant of the departing quintet – that honour belongs to *Voyager 1* with a speed of 17km/s and a distance of 25 billion kilometres from Earth (compared with 21 billion for *Voyager 2*). But with *Voyager 2's* trajectory lying almost 60° below Earth's equator, it's too far south to be accessed by the other two DSN telescopes. Tidbinbilla is the vital link.

For 60 years, Tidbinbilla has been playing its part in the DSN's activities, and it has supported hundreds of space missions. Opened in March 1965, it was once one of three tracking stations in the ACT; the others, at Orroral Valley and Honeysuckle Creek (famous for its role in NASA's Apollo Moon missions), were closed in the 1980s.

As Tidbinbilla celebrates its 60th birthday this year, we can proudly reflect on its past achievements and look forward to a bright future of interplanetary communications.

FRED WATSON is an honorary professor at Macquarie University and was Australia's first Astronomer-at-Large. You can find him on ABC Radio, the weekly Space Nuts podcast and on X @StargazerFred.

PHOTO CREDITS, FROM TOP: MARK GRAHAM/AFP/GETTYIMAGES; SHUTTERSTOCK

Looking up by Glenn Dawes

May–June is a great time of year to see the galactic centre of the Milky Way. The eastern evening sky now sees Sagittarius, with its famous teapot asterism (star pattern), on its side. Directly above lies the scorpion pattern of Scorpius. These constellations are two of the most recognisable asterisms visible from suburbia. But moonless country skies reveal the true majesty of our galaxy, including the prominent dark rift that runs from the lower left and passes up and through the scorpion's tail. Numerous bright spots are visible, including those running along the edge of this dark void. Binoculars will reveal some as large, open star clusters. A few that are bright gas clouds and a couple of clearings in the fog give a deeper view towards the hidden core some 30,000 light-years away.

Full Moon
Tuesday
13 May

New Moon
Tuesday
27 May

Full Moon
Wednesday
11 June

New Moon
Wednesday
25 June

19 APRIL – 28 MAY 2025

Repeating shooting stars!

Comets drop debris along their orbits, and when Earth passes close to some of these paths they cause shooting stars. In May each year we pass close to the orbit of the famous Halley's Comet, causing the Eta Aquariids meteor shower. It's named after a star located in the direction from which the meteors seem to appear, low in the north-eastern morning sky. Although active from 19 April to 28 May, its numbers are expected to peak around 6 May. While only a handful may be seen per hour, the Eta Aquariids are known to be bright, swift and yellow in colour – impressive!

GLENN DAWES is a co-author of the yearbook *Astronomy 2025 Australia* (Quasar Publishing), which can be purchased from Australian Geographic. **See:** *australiangeographic.com.au*

EARTH VIEW
PERSPECTIVE

Time to plug holes in species conservation

To prevent extinctions, we need to start addressing the big gaps in our national threatened species list.

NINETY-SEVEN PER CENT of Australians are concerned about the potential extinction of native animals, and two-thirds are very or extremely concerned. This is a key finding from a large community survey conducted by Monash University for the Biodiversity Council.

People have valid reasons to be concerned. During the past two centuries, Australia has maintained a dismal record of biodiversity loss, and despite increased awareness today, the rate of loss continues to increase.

No one will ever again see the Daintree's river banana (*Musa fitzalanii*), pig-footed bandicoot (*Chaeropus* spp.), big-eared hopping mouse (*Notomys macrotis*), Tasmanian emu (*Dromaius novaehollandiae diemenensis*), paradise parrot (*Psephotellus pulcherrimus*), Christmas Island forest skink (*Emoia nativitatis*) or Eungella gastric-brooding frog (*Rheobatrachus vitellinus*) – and we and the ecosystems they were once part of are poorer for it.

Officially, 35 plants, 39 mammals, 22 birds, 4 frogs, a reptile and a giant earthworm have been declared extinct in Australia. And 'officially' is an important qualifier in that sentence, reflecting the limited resources dedicated to understanding, documenting and conserving Australia's unique natural heritage. The actual number of Australian extinctions since European arrival is very likely significantly higher, and recent research suggests it probably includes the Kangaroo River perch (*Macquaria* sp.), along with approximately 9000 native invertebrates.

Preventing extinctions and recovering threatened species is one of Australia's obligations under the Kunming–Montreal Global Biodiversity Framework, the biodiversity equivalent of the Paris Agreement. The Australian Government, along with 195 other governments, has committed to this goal.

However, government policies and investments are grossly inadequate to stop the decline of nature. There isn't enough government funding or effort to identify and list all the species that are in trouble – let alone conserve and recover them.

Until a species is listed as threatened under our national environmental law – the *Environmental Protection and Biodiversity Conservation Act 1999* (the EPBC Act) – it receives little attention or protection. Listing species under the EPBC Act lets management agencies and the community know that these species are in danger, affords them some legal protections, and hopefully also leads to new conservation actions. It gives us a last chance to pull things back from the precipice before irreversible extinctions.

Our existing listing assessment process is resource-intensive and under-resourced. There's a backlog of species to assess, and as a result, far fewer species are being added to the list than are actually at risk. While more than 2000 species are currently listed under that Act, we estimate that at least 2000 more are likely to be at risk and would also meet the criteria for listing. The Australian Government will need to properly resource this small but important area of work to meet community expectations and government commitments to prevent extinctions.

The Christmas Island forest skink was declared extinct in 2014.
Photo credit: Chris Bray

Most of our plants and animals are unique to Australia, making us their sole custodians and protectors. Their survival truly rests in our hands as a nation.

HUGH POSSINGHAM, the Biodiversity Council's Co-chief Councillor, is a Professor of Mathematics and Professor of Ecology at The University of Queensland. He was founding Director of the Australian Research Council Centre of Excellence for Environmental Decisions and the National Environmental Science Program Threatened Species hub.

EMBRACING ALL LIFE

Driven by tragedy, philosopher Danielle Celermajer champions radical kindness for the earth and its creatures.

"I have a unique relationship with her," Danielle says of pig Penny. "She's the only non-human animal I've ever known who argues with me."

STORY BY **KAREN MCGHEE**
PHOTOGRAPHY BY **TAMARA DEAN**

FOR SOMEONE WITH so much horror embedded deep in her DNA, Danielle Celermajer radiates a lot of joy and positivity. Conversations with her are intensely thought-provoking and frequently touch on topics of despair. And yet, ultimately, they're also delightfully uplifting. You come away from spending time with Danielle sensing that you've been in the company of one of Australia's – and perhaps the world's – most profound thinkers. And you're reassured that an extraordinary intellectual prowess is being directed into making the world a considerably better place.

Dr Danielle Celermajer is a professor of sociology and criminology at The University of Sydney (USyd) and has been a human rights advocate for more than three decades. These days, however, she's more active as an academic helping shape answers to some of earth's most pressing challenges. Her core research interests extend well beyond justice for humans – and even other animal species – to encompass all life. She's deputy director of the Sydney Environment Institute, and lead of the Multispecies Justice Collective.

At the heart of her work are profoundly philosophical concepts that might be hard for many people to grasp, but which become clearer after hearing how she got to this place in her life.

DANIELLE KNEW SHE wanted to work for human rights from an extraordinarily young age. "I was very clearly brought up in the shadow of the Holocaust," she says, detailing the heartbreaking experiences of her Jewish family who lived in Poland at the outbreak of World War II. "It's a very important part of how I narrate myself."

Both Danielle's parents were young children during the war. "My mother was born in '38, my father in '35. My parents were hidden during the war…but my father's sister [Alma], who was 12, was murdered," Danielle says.

After WWII, her parents ultimately came to live in Australia, where they met and married. Danielle and her brother, David Celermajer, now a professor of cardiology at USyd, were born in Sydney in the 1960s. And throughout their childhood, their father, John, and mother, Tina, reinforced that memories of wartime horrors could be turned around and used for good. "They were adamant about our responsibility to make the world a better place," Danielle says. Even as a child, this became entrenched in her psyche, fuelling her ambition to pursue human rights. "I became very focused on how we could create institutions and societies where atrocities don't get normalised."

The horrific experiences of her family drove her from a young age. "It felt very epigenetic," she says, alluding to the scientifically proven concept that environmental effects can make long-lasting structural changes to a person's DNA, affecting how their genes are expressed. "My grandmother told me about being tortured when I was four, so I was saturated with that reality."

Danielle went on to study philosophy and social policy as an undergraduate, and quickly followed that with a master's degree in philosophy and a PhD in political science and international law. She worked for Australia's Human Rights Commission and as a speechwriter for Indigenous barrister and academic Professor Mick Dodson.

Understandably, Danielle was, she admits, a "very intense" child, and that intensity has carried through to her adult life. At the same time, and very importantly, her narrative has been consistently entwined with a love of animals. "I've always had an easy connection with, and loved, other animals very much," she says. In fact, as a child, she felt more at ease with other animals than with humans, and she also felt a very deep connection with the environment.

Around the time of the death of her mother, Tina, about 10 years ago, Danielle had an epiphany. It was "universalism" that had attracted her to human rights – the idea that justice belonged not only to the people of a nation or a particular gender or race. Anyone was entitled to justice. And yet, now it dawned on her that the usual doctrines surrounding justice, human rights included, weren't truly universal; they stopped at the edge of the human condition. "I had been very committed to human rights work, but there was a type of disconnect between how I felt about the world, about all earth beings, and what I was doing for my work," she recalls.

And then it all began to come together for her.

"We've convinced ourselves in the West that humans are exceptional because we've got reason, we've got language, we've got, you know, a soul – whatever the justification is," Danielle says. "But so much of that is falling away now as we learn more about other animals and forests and fungi and mycelium [the nerve-like fungal connections that spread through forest floors]. And we're learning more about how humans are always entangled and interdependent with earth, and not only the human world. Of course, Indigenous peoples have always known this, but their knowledge has been systematically dismissed."

She thought deeply about the widespread fundamental questions about justice that arose after WWII and how, of course, they were relevant not just to individual nations but also to all humans. And then she had a crystallising eureka moment, the likes of which so many people spend a lifetime searching for. "What would it mean if we said justice isn't ►

just for humans, but it's for all earth's beings?" Danielle says, her face becoming animated and her mood suddenly lightening. "And that question, honestly, that question! Once I started to ask it, it felt like it was the absolute core question of my life."

She gave it context, in her thoughts, to scenarios such as climate change and ecological collapse as she developed her philosophy. "We know that the way most humans have come to live on the planet is so destructive, not only for ecological systems and other animals but for the very conditions of life," Danielle says. "It just seemed that if we're not asking about how we create conditions where all earth's beings can flourish, then we're not asking the right questions."

It was, for Danielle, a very "weighty realisation". And it's now at the heart of so much of what she does, both professionally and personally. To put it simply, Danielle's work and life are now about applying the principles and philosophies underpinning ethical understandings of justice to all aspects of life on the planet.

It was a life-changing moment. Danielle realised that she, herself, was also part of this world that saw humans as exceptional beings beyond all other life forms – and that if she was going to answer the questions that her new realisation raised, she, herself, needed to change. "I needed to be re-formed as well," she says. "And that was when we moved out of the city." Danielle and her partner, Leonard, wanted to live in an "intentional multispecies community", away from the concrete, steel and asphalt of a city – namely Sydney – heaving with humans and suffering from a shortfall of other species. "I wanted to live with forests, with animals, with soil, with a river," Danielle says. "And I didn't just want to do this as an intellectual exercise. I wanted to remake myself so that I could do the work with authenticity."

She realised also that she'd come to the age where her grandparents, refugees to Australia, had made profound choices in their lives to ensure safety for those who'd come after them. "The future that my beloved kids – my daughter, Arielle, and two stepsons, Sacha and Hugo – were facing made viscerally real the precarity of life for all future generations," she says, "and that it would not be money, but fertile land and clean water – and a connected and caring community – that might hold them."

She and Leonard found and moved to a property on the NSW South Coast where they could be surrounded by nature, including other animals both native and domesticated. But Danielle's world was soon impacted again by horror when the Black Summer bushfires of 2019-20 erupted. She and Leonard, along with the domesticated animals who lived with them, were evacuated, but her dear friend Katie – a pig with whom she'd developed a particularly close bond – was evacuated to land that two days later became one of NSW's worst fire grounds. Katie was killed.

The effect, though, was to strengthen her resolve that her work was heading in the right direction. "As we were on our way back south [after one of several evacuations] I was listening to the radio, and they kept talking about the fires as a tragedy, about how all the death of the animals had been a tragedy that resulted from a natural disaster," she says. "And it struck me that those words completely obviated our [human] responsibility." The event wasn't a tragedy caused by a natural disaster; rather, it was a crime triggered by human-induced climate change.

> **"What would it mean if we said justice isn't just for humans, but it's for all earth's beings? ... It was the absolute core question of my life."**

Already a highly accomplished author of several books, Danielle penned an essay entitled *Omnicide: Who is responsible for the gravest of all crimes?*. The word omnicide came to her sitting in the car that day – 'omni' meaning all and 'cide' meaning murder or killing with responsibility. "I later discovered it had, appropriately, been previously coined by people trying to describe the full-scale devastation of nuclear war. Like them, I reached for a word that went beyond any delimited killing, a word that would describe the profound ethical crime of killing all that is," she recalls. "So, I came home and wrote that piece." Shortly after, she wrote and published a powerful book about the fires entitled *Summertime: reflections on a vanishing future*.

IT'S PERHAPS NOT surprising that Danielle nominates her greatest influence as the Jewish philosopher Hannah Arendt, who escaped to France from Germany in 1933 after being imprisoned by the Gestapo and ultimately lived in the United States. Known as one of the most influential political theorists of the 20th century, Arendt's major written works include *The Origins of Totalitarianism*, *The Human Condition* and *Eichmann in Jerusalem*.

"She was an extraordinarily independent and very political thinker," Danielle says. "I consider that my work is intellectual – you know, I'm an ideas person – but she is the person who, for me, most strongly insisted that your ideas must always be formed in an encounter with the world as it is."

To elaborate on what she means, Danielle continues. "There's a wonderful line in an interview [Arendt] gave where she's asked, 'When did you start to feel responsible?' and she replies, 'The burning of the Reichstag in 1933'. That was when I realised that philosophers are trapped in their ideas, and that to be a responsible philosopher means to be in confrontation with the world as it is."

For Danielle, that means she must question her role as an intellectual in the context of issues such as climate change and ecological collapse.

"As you get older, you realise the complexity and enormity of what we're dealing with. The best thing you can do is to work out, what's my [role] here? What do I do really well, and how can I do that in collaboration with others?" she says. "And that, for me, is to understand how things came to be the way they are. Like, why are we in this shitshow of ecological destruction? And how could we imagine our way out of it?"

To answer these questions, Danielle returns to her family's history. "Because my aunt Alma was murdered when she

Donkeys Zoro, left, and Jasper are frequent companions for Danielle on walks of her NSW South Coast property.

was 12, that reality of ultimate suffering has been very present with me all my life. But I've always thought, what was that like for her? Would it have been better for her if, at the end, she had someone with her who loved her no matter how bad it was?"

It's a perspective Danielle transposes onto what's being faced by the planet. She envisages a future of inevitable death, extinction and suffering.

But how that unfolds, she says, will be the responsibility of humankind's collective power. "Life is an incredible gift, and we live in such an infinitely wondrous universe. We think the planet belongs to us, but we've forgotten that we belong to the planet," Danielle says.

"What we're seeing at the moment are the politics and sociality of incredible cruelty. And as people become more and more afraid, cruelty is ascendant.

"We could be kind. We could care for each other. We could care for other animals, even as we're suffering, even as things are unravelling. And if we could, we should."

Ultimately, it seems, that to a person whose existence has been immersed in immense cruelty since before she was even born, the answer to the future of the planet is kindness. ■

Australian Geographic Society

NOMINATIONS ARE OPEN!

Could Aussie polar explorer Eric Philips (left) be your nomination for an adventure award this year?

WE ARE ACCEPTING nominations for the Australian Geographic Adventurer of the Year awards in May and June.

Australian Geographic's annual adventure awards are the longest-running and most prestigious accolades for Australia's adventure community. Last year we honoured four amazing individuals who each exemplified personal qualities of courage, endurance and dedication while achieving ambitious goals over extended periods of time (see AG 184 for full story).

The four award categories are explained on the right-hand side of this page. To find out more about how to nominate someone – and read updates on our past adventurers, including James McAlloon, Lisa Blair, Michael Smith, Alexander Campbell and Sebastian Howe – visit our website at *australiangeographicsociety.org*. Nominations close on 30 June.

Last year we replaced the annual gala awards dinner in Sydney with smaller speaker events held at selected venues around the country, giving our readers the chance to hear from our winners in a more intimate and interactive setting.

Since then, we have held six awards roadshow events across four states, and we have another exciting opportunity coming up in July. Turn to page 35 to learn how you can see Paul Pritchard's new documentary and meet the remarkable man in person.

We thank Coral Expeditions for their partnership in our adventure program and events.

CHRISSIE GOLDRICK
Chair, Australian Geographic Society
cgoldrick@australiangeographic.com

Australian Geographic Adventurer of the Year categories

Young Adventurer of the Year

Typically awarded to a person under the age of 30 for an expedition or adventure from the past 24 months.

Spirit of Adventure

This is awarded to those whose efforts reflect strength, determination and the ability to overcome obstacles. It also acknowledges that sometimes it takes more than one attempt to achieve those goals. It usually reflects an achievement or attempt from the past 24 months.

Adventurer of the Year

This award usually reflects a particularly notable adventure achievement from the past 24 months.

Lifetime of Adventure Award

This is the Society's highest honour and recognises special Australians who have lived an adventurous life and inspired others by their leadership and example. There are no age limits but it's customary for the medallion to be given to an older Australian.

AUSTRALIAN GEOGRAPHIC
ADVENTURER OF THE YEAR
WITH PRESENTING PARTNER coralexpeditions

PHOTO CREDIT: COURTESY ERIC PHILIPS

AUSTRALIA'S MOST ENDANGERED

AGS FUNDRAISER

Leap into action for the yellow-footed rock-wallaby

Wombats may be famous for their square-shaped poo, but did you know the yellow-footed rock-wallaby's poo is shaped like a torpedo?

In 2017, a decade after Bush Heritage Australia purchased Boolcoomatta Reserve in South Australia, scientists and reserve managers were overjoyed to discover the wallaby's unique scat on the property. The wallabies hadn't been seen in the area for more than 90 years, but since discovering their pooey torpedoes in 2017 there have been regular sightings on the reserve.

Ecologists at Bush Heritage are working to conserve Boolcoomatta Reserve's habitat so its yellow-footed rock-wallaby (*Petrogale xanthopus*) population can thrive. This includes removing introduced species such as foxes, goats and rabbits, as well as controlling weeds.

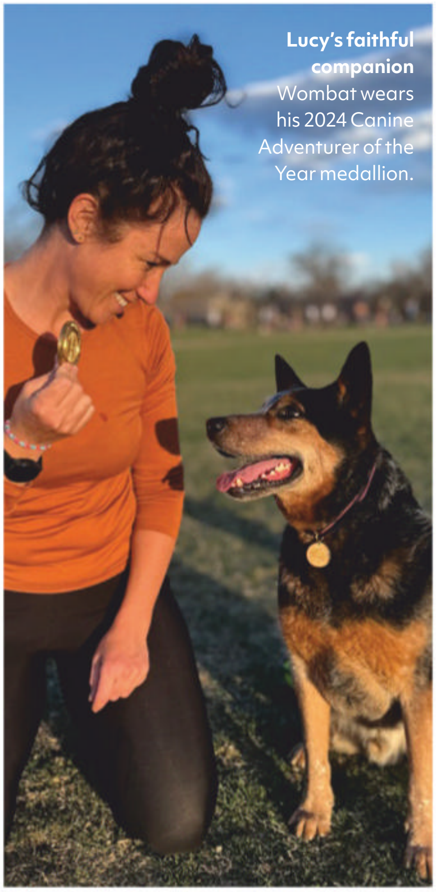
Donations towards the yellow-footed rock-wallaby will support the complex and challenging work of restoring native habitats, including weed removal, tree planting and ecological surveys.

Please be generous and help the yellow-footed rock-wallaby bounce back to South Australia's arid rangelands on Adnyamathanha and Wilyakali country. Please visit our website at *australiangeographicsociety.org* or scan the QR code.

Donate to our Australia's Most Endangered yellow-footed rock-wallaby campaign at ***australiangeographicsociety.org***
All donations over $2 are tax deductible.

This pretty wallaby species is best known for its colourful fur patterns.

ADVENTURE NEWS



Lucy's faithful companion Wombat wears his 2024 Canine Adventurer of the Year medallion.

In April 2025 polar guide **Eric Philips**, recipient of the 2015 Lifetime of Adventure Award, became the fourth Australian in space when he participated in SpaceX's historic Fram2 mission. It was the first human spaceflight to orbit Earth via the north and south poles.

Launched on 1 April from NASA's Kennedy Space Center aboard a SpaceX Crew Dragon capsule, the mission was funded by cryptocurrency entrepreneur Chun Wang, who was also part of the crew. He was joined by Norwegian filmmaker Jannicke Mikkelsen, German robotics researcher Rabea Rogge, and Eric, who served as mission specialist and medic.

For three-and-a-half days, the crew completed approximately 55 polar orbits. They conducted 22 scientific experiments, including capturing the first human X-ray images in space to study microgravity's effect on human physiology. They also grew oyster mushrooms in microgravity, contributing to research on sustainable food sources needed for long-duration space missions.

The mission ended with a successful splashdown off the California coast on 4 April, marking the first Pacific splashdown for a Crew Dragon mission.

Eric's participation in Fram2 is a milestone in private space exploration, blending his extensive polar experience with groundbreaking research conducted in Earth's polar orbit.

In other news, **Lucy Barnard** has reunited with blue heeler Wombat – who was awarded a 2024 Canine Adventurer of the Year medallion – in Wyoming in the western USA.

Lucy has now resumed her expedition to walk the length of the world, making her way along the Continental Divide Trail. She's about to take on Yellowstone National Park in Wyoming before continuing north to the Canadian border. She hopes to enter Alaska by the end of 2025.

You can keep track of Lucy's (and Wombat's) adventures by following her Instagram page: *@tanglesandtail*

PHOTO CREDITS, FROM TOP: ESTHER BEATON; COURTESY LUCY BARNARD

Staff from Great Barrier Reef Legacy gather around the coral biobank.

CONSERVATION NEWS

In March, **Forever Reef** – winner of the gold tier $50,000 Awards for Nature grant last October – opened its brand-new HQ in Port Douglas. The team spent six months fitting out its new premises at the Crystalbrook Superyacht Marina, relocating its precious coral collection from Cairns Aquarium into its new home.

This move marks a homecoming for the project, because Port Douglas was once the base for the Great Barrier Reef Legacy; it's where they launched their research expeditions, engaged with local schools and businesses, and grew the organisation with the support of the community.

"Bringing this world-class conservation initiative home to Port Douglas is immensely rewarding as it is now one of the most significant coral conservation projects globally, and it belongs right where it all began," says Dr Dean Miller, CEO of GBR Legacy and leader of Forever Reef. "The expansion strengthens collaborations with Traditional Owners, scientists and conservation groups. We work closely with the Jabalbina and Dawul Wuru Aboriginal corporations and are developing a First Nations Forever Reef 'Hub' to protect coral biodiversity on Country."

The centre also has dedicated tourism, education and training spaces, reconnecting the project with the Port Douglas community.

"We're now awaiting the end of this year's bleaching event so we can once again start to collect Great Barrier Reef hard-coral species and work towards collecting all 415 known species before the end of 2026. The Society grant money will be absolutely instrumental in supporting these collecting expeditions, as well as creating our first Hub facility," Dean says.

Dr Judy Friedlander, leader of **B&B Highway** – recipient of the $20,000 bronze tier Awards for Nature 2024 grant – has compiled her exhaustive knowledge of pollinators into an entertaining new book, *The Bee Squad*. The book explores ways to boost biodiversity in your neighbourhood by making your garden or balcony more pollinator-friendly. It also offers tips on how to get kids more engaged with nature.

The Society helped Judy launch the book at an event at Canva Space in Sydney on 26 February. Biodiversity advocate and TV presenter Costa Georgiadis was the special guest speaker, along with 12-year-old Molly Moriarty, a presenter on ABC's *Gardening Australia Junior* show.

We hope to welcome Costa as our special VIP guest presenter at the Australian Geographic Awards for Nature in Sydney in October. Many thanks to Canva for enabling and supporting the book launch – our second book launch in that great space.

Dr Judy Friedlander delivers a speech at *The Bee Squad* book launch.

PHOTO CREDITS, FROM TOP: DEAN MILLER; CHRISSIE GOLDRICK

EVENTS

Australian Geographic Awards Roadshow with Paul Pritchard

Learn about the inspiring life of Paul Pritchard in this Q&A.

Q&A Screening of *Larapinta: End to End*

with Paul Pritchard and guests

Hosted by Chrissie Goldrick,
chair of the Australian
Geographic Society

Despite catastrophic injuries sustained during an ascent of the Totem Pole in Tasmania in 1998, the Society's 2018 Spirit of Adventure winner Paul Pritchard has continued to lead a life filled with adventure as a climber, caver, cyclist and kayaker. Despite suffering from hemiplegia, he leads expeditions that enable fellow adventurers with disabilities opportunities to achieve record-breaking feats of endurance.

In 2022 he walked the Larapinta Trail in the Northern Territory with three fellow adventurers with medical and mobility challenges. That expedition has been turned into *Larapinta: End to End*, a heartwarming film about overcoming the odds and finding courage – with plenty of humour. Don't miss the opportunity to see this inspiring documentary and hear from Paul, a gifted speaker. All proceeds go to the Australian Geographic Society.

Where: Library Auditorium, State Library of New South Wales, Macquarie Street, Sydney, NSW 2000

When: Wednesday 23 July 2025 at 6.30pm

Tickets: $35 for general admission. $30 for AG subscribers. $15 pension card holders and full-time students under 30. School students free, but must hold a valid ticket booked in advance.

Where to book: *events.humanitix.com/larapinta-end-to-end-q-and-a-screening-with-paul-pritchard-and-guests*

Coral Futures Expedition

The Society is joining forces with Forever Reef and Coral Expeditions to offer a very special travel opportunity on the Great Barrier Reef in December this year.

The seven-night voyage, departing on 4 December 2025, will be hosted by Dr Dean Miller and feature other expert guides. The expedition will contribute to reef conservation initiatives such as the Forever Reef Project, and to the Society's Awards for Nature program. Don't miss this unique opportunity to travel with purpose, combining adventure with science to safeguard the future of our greatest natural asset. Prices start from $8650. For more information, see page 116.

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Framed by large gum trees, the property's brand-new school is specially designed to cater to the needs of children with autism spectrum disorder.

A BREATH OF FRESH AIR

On a purpose-built farm in Victoria's High Country, families dealing with autism find a place of therapy and respite.

STORY AND PHOTOGRAPHY BY **DON FUCHS**

AFTER MORE THAN 50 years of existence, Mansfield Autism Statewide Services (MASS) outgrew its facilities. Overwhelming demand and excessively long waitlists called for urgent expansion. So in 2020, MASS, a not-for-profit that supports young people with autism spectrum disorder (ASD) and their carers, bought a property in Victoria's High Country. And there, cradled by the Aussie bush, it created a farmstay that offers respite and therapeutic care for kids with ASD and their families.

"Through a combination of government grants, philanthropic trusts, donations, fundraising events and our own contributions, we've almost finished our $40 million expansion plan on our 100-acre farm on the rural outskirts of Mansfield," says Simone Reeves, director of MASS. "Our new property now has a new school building, 12 retreat cabins where we hold family camps and carer retreats, skill-building stay houses, a meeting hut, a multipurpose activity centre, new office space and a perimeter walking track."

The buildings are strewn across a gently sloping rural property where nature dominates. Wooded hills form a picturesque backdrop. Large gum trees, a dam and open grass areas create a park-like environment. An occasional mob of kangaroos completes the picture. In the distance looms the blueish skyline of the Victorian Alps. Arriving at this scenic property has an immediate calming effect.

This is by design. "The environment is autism-friendly – it really helps [ease] their anxiety," Simone says. "It reduces the transitions for the children because autistic children can have real challenges with transitioning [dealing with change]."

The combination of nature, space and quietness – and the fact that it's not very busy – is key. "We have control of who's coming and going, what's happening, so there's nothing unpredictable," Simone says. "We reduce that unpredictability, which can really heighten autistic people."

For Dani and Alan Netherclift, parents of 12-year-old Perry, the farm is a godsend. The Netherclifts are in crisis and are here for a family camp, which offers respite and a chance for parents to build their capacity through autism-specific training, supported by a balanced program of relaxation, outdoor experiences, nature, art and craft, yoga, games, healthy foods and exercise.

Fatigue is etched into their faces. They've just arrived at the farm for the initial parents' meeting clutching coffees and Red Bulls. Their son, diagnosed with ASD and Intellectual Disability, has been spiralling downwards for a while now. Perry is also minimally verbal, so conversations are not possible.

"Where he [is] at the moment has been building for about two years," Alan says. "He started just hitting himself on the head a bit two years ago and it's been slowly building, until a couple of months ago when it just went off the charts. We went into total crisis." Having a child with ASD is an unrelenting commitment. Life is an emotional rollercoaster and the toll on parents is immeasurable. At the farm, the children are looked after and the parents get to have a break.

"Respite is one of the biggest things you really need," Dani says. "Having a chance to turn off for a while and just sit and stare at the television or do nothing gives us a chance to catch our breath."

MASS follows the philosophy of its founder, Dr Joan Curtis: "The child's family is their most important teacher, and we aim to give them the understanding, the confidence and the determination necessary for the successful parenting of their child. That is our goal, and nothing less is enough."

For Simone, supporting parents and family is key. "Autism doesn't just impact the child," she says. "It can really impact the family, and by being able to have the families come and stay on the farm with children and siblings we are actually able to support the family and really honour childhood."

For parents, it can be a steep learning curve. "[Once] Dani and I knew what was going on with Perry, we sort of went, 'Right, we're not going to change our boy to fit in with the world. We're going to change the world to fit in with our boy,'" Alan says. "What we didn't realise is we were literally bubble-wrapping this kid [by] doing everything for him, which stopped him learning [to do] it himself."

Dani agrees. "You have to learn this balance of knowing when to pull back, but also when to push them a little bit harder than you feel naturally inclined to do," she says.

Children with ASD relax around the firepit (opposite) with their parents and carers during family camp week.

Perry Netherclift (left) settles into a pod swing in the farm's sensory room after a stressful episode.

IT'S LATE MORNING. The day is cloudless, and a cool mountain breeze keeps the temperatures in check. Perry is walking the perimeter track, accompanied by his carers Renee Moxham and Maddison Barlow. They pass the meeting hut, built like a rustic high-country hut, when a distant sound triggers him. He goes into a meltdown.

"A meltdown for Perry means banging his head quite forcefully, violently, terrifyingly," Alan says. "He hits his forehead with his forearms as hard as he can. He also knees himself in the head really hard, and it's really loud when he does it. He headbutts tables or the walls or the floor. It's incredibly distressing for him and for us."

"That's his anxiety reaction to anything in life," Dani adds. "That way he gets a kind of neural feedback that perversely helps him process a stressful situation."

“The realisation that they’re not alone...and that other families are going through similar experiences is of immense value to the parents.”

While Renee rushes back to fetch noise-cancelling headphones, Maddison sits with Perry on the track. He often wears headphones to shield him from noises that can trigger him, such as the screech of a cockatoo, the sound of a lawnmower or the buzz of a drone.

Renee and Maddison spend the rest of the day calming Perry down. They bring him to a sensory room with a pod swing, and the hammock’s soothing effect on Perry is immediate. It’s in situations like these that the uniqueness of the farm becomes apparent. These calming, low-sensory spaces are necessary for caring for children with ASD. The availability of such spaces is what makes this facility unique in Australia, if not the world.

Renee and Maddison are just two of a host of residential care workers dedicating their working hours to helping kids with ASD at the farm. There’s also a speech pathologist and an occupational therapist on site.

During camps, families stay in modern, spacious villas that are specially designed to support families with children with ASD. The 12 villas are set on a small rise overlooking the property and offer beautiful views of Mt Buller. Meals for the families and the carers are prepared in the centre’s professional kitchen and served in the dining hall.

The day Perry has his meltdown, Dani and Alan are out for lunch in Bonnie Doon, a small holiday village on the shores of nearby Lake Eildon. Together with the other parents attending the family camp, they get to have a much-needed break. As well as the lunch outing, Dani and Alan participate in a dance lesson, go on a walk along the Delatite River and have a picnic.

Activities like this provide them with a small dose of normality and allow them to connect with other parents. This important process begins at the parents’ meeting on day one. At this initial get-together, parents share their stories, and emotions run high. There’s a sense that they’re all at the end of their tethers. The realisation, however, that they’re not alone in their difficult journeys and that other families are going through similar experiences is of immense value to the parents.

CAMPS AT THE farm also give parents the opportunity to reconnect with their partners, because caring for a child with ASD can have a brutal impact on a relationship.

“It has a dual impact,” Alan admits. “I think it very much damages our relationship, but at the same time it holds it together. We couldn’t do it without each other. We get very short with each other a lot. Luckily we both recognise that and apologise afterwards.”

Many couples with children with ASD don’t survive the ordeal. “We live our life hypervigilant,” Alan says. “Perry needs 100 per cent supervision 100 per cent of the time – except when he’s asleep.”

Part of the program for Perry is a yoga session inside the new school building, which has many features that regular schools don’t have. Classrooms have their own little courtyards where children have the choice to be inside or outside. There are breakout spaces for children who don’t want to be around other children. Curved walls in the corridors reduce noise, and some classrooms are equipped with one-way mirrors for parents, staff and trainees to observe the children without interrupting them.

The next night, parents and their children gather at the meeting hut. This rustic shelter forms the nucleus of social activities at the farm. A fire is blazing. The kids roast marshmallows on sticks. A carer unpacks his guitar and plays songs. The mood is relaxed, the conversation is flowing, and the day is slowly fading. And everyone has a chance to catch their breath. ■

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COME HITHER

STORY BY **LIZ GINIS**

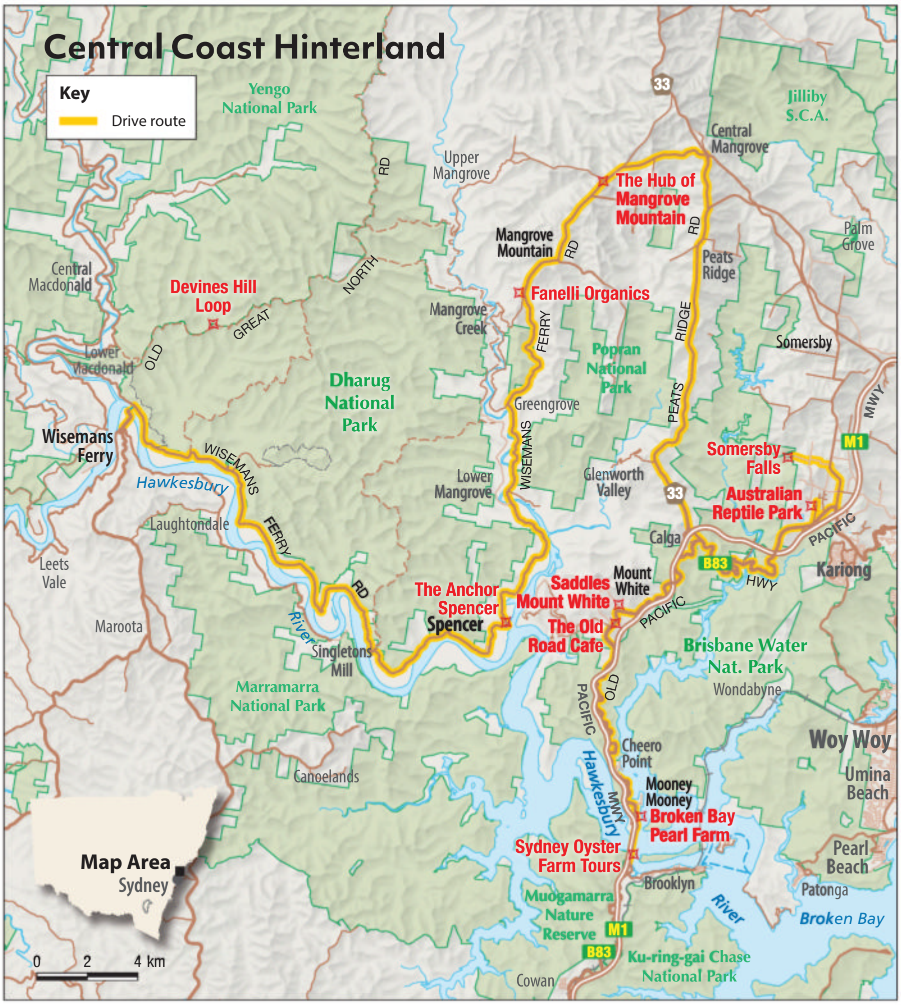
The NSW Central Coast hinterland beckons with its eco-certified blend of nature, heritage and gourmet experiences.

THERE'S A CERTAIN thrill in trading a well-worn highway for scenic backroads that whisper history and adventure. Tourist Drive 33 offers exactly that, an enticing journey through the lush hinterland of the New South Wales Central Coast. More than just a road trip, this route showcases a seamless blend of nature, heritage and gourmet experiences. The Central Coast is already a leading ECO Certified Destination, recently acheiving 'Ecotourism' status – a promotion from its previous 'Nature Tourism' status and a testament to the region's commitment to sustainable travel and environmental conservation.

Mooney Mooney: pearls and oysters by the water

My journey kicks off at Mooney Mooney, a peaceful riverside village where Broken Bay Pearl Farm offers a glimpse into NSW's only pearl farm. Joining a tour, I watch in awe as experts deftly extract lustrous gems from oysters – an age-old craft that feels worlds away from modern hustle. The onsite shop tempts with elegant pearl jewellery, each piece telling a story of the Hawkesbury River's pristine waters.

Next up is a truly unique experience: Sydney Oyster Farm Tours. Clad in waders, I walk into the water for a dining adventure in the oyster lease.


Central Coast Hinterland
Key
Drive route
Yengo National Park
Upper Mangrove
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33
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Palm Grove
Peats Ridge
Central Macdonald
Devines Hill Loop
GREAT NORTH RD
Fanelli Organics
Mangrove Creek
Lower Macdonald
OLD
Dharug National Park
Popran National Park
Somersby
Greengrove
PEATS RIDGE RD
FERRY
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M1
Wisemans Ferry
WISEMANS FERRY RD
Hawkesbury River
Lower Mangrove
Glenworth Valley
Somersby Falls
Australian Reptile Park
Laughtondale
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The Anchor Spencer
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Mount White
Maroota
Singletons Mill
The Old Road Cafe
PACIFIC
Brisbane Water Nat. Park
Wondabyne
Marramarra National Park
OLD PACIFIC
Woy Woy
Cheero Point
Umina Beach
Canoelands
Mooney Mooney
Broken Bay Pearl Farm
Hawkesbury River
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Pearl Beach
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Bushwalks abound on the NSW Central Coast, including the Piles Creek loop (left) in Brisbane Water NP. Join a Shellar Door tour (right) at Broken Bay Pearl Farm, NSW's only pearl farm.

The briny scent of the Hawkesbury mingles with the taste of freshly shucked oysters, each one a salty burst of pure indulgence. It's a sensory moment that reminds me how deeply connected this region is to its waterways.

Mount White: culinary gems and a nostalgic pit stop

Following the Old Pacific Highway north, the first stop in Mount White is Saddles, an elegant gourmet restaurant and bakehouse set around a tranquil dam. It was recently named one of the world's most beautiful restaurants. Inside, the scent of fresh bread with smoked butter and house-made pork ►

PHOTO CREDITS: JAMES VODICKA (ABOVE); JAMES HORAN (RIGHT)

and sage sausage rolls fills the air. The menu is a nod to local produce, with head chef Reece Collins curating a menu that focuses on the paddock-to-plate philosophy.

But Saddles is as much about the ambience as it is about the cuisine. Leather saddles crafted by master saddler and horse trainer Heath Harris are used as bar stools, evoking the rural charm of the region. The Saddles Barn, a newly opened function centre, is also enchanting, artfully melding timeless elegance and rustic charm.

Just down the road, The Old Road Cafe beckons as a favourite haunt for motorcyclists and road-trippers alike enjoying the wending road through stands of eucalypts. A classic pit stop open from 7am daily, it's a place where espresso machines hum and conversation flows between travellers sharing stories of the open road.

Don your waders at the Sydney Oyster Farm Tour (top left) and meet furry locals at the Australian Reptile Park (left). Enjoy quintessential Australian dining at Saddles Mount White (below).

Somersby: wildlife wonders and cascading falls

No Central Coast hinterland adventure is complete without a visit to the Australian Reptile Park. Its enclosures brim with delightful native characters (think kangaroos, koalas, wombats, dingoes... and the enormous and iconic saltwater croc, Elvis). Don't miss the recently opened Weigel Venom Centre, where spiders and snakes are milked to make antivenom.

"The Australian Reptile Park is Australia's original hands-on zoo," says park director Tim Faulkner, emphasising its unique approach to animal encounters. "It's about Australian wildlife and the conservation of threatened Australian species. That's why the bush setting is important too. And it's why you won't see lions, tigers or bears here."

A 10-minute drive from the reptile park, and nestled within the bushy embrace of Brisbane Water National Park, is the Bulgandry Art Site Aboriginal Place, which features Aboriginal rock engravings estimated to be more than 200 (if not thousands of) years old. The site's namesake, Bulgandry, refers

Stretch your legs on Devines Hill loop, a convict-built trail in Dharug NP.

to a prominent engraving believed to depict an ancestral hero adorned with an elaborate headdress. The site also showcases engravings of native fauna such as wallabies, fish and a dolphin, as well as depictions thought to represent a canoe and a bird. Nearby, you can observe stone tool sharpening grooves, further illustrating the daily lives of the area's original inhabitants.

When you're done imbibing the history of Bulgandry, make a beeline for the enticing tumble of Somersby Falls, also located in the national park. Somersby Falls picnic area is your jumping-off point. Here you'll follow an 800m walking track through rainforest, the sound of rushing water growing louder until you reach the three-tier falls. The air is thick with the scent of eucalyptus. Local wildlife, including water dragons, frogs and goannas, are often oblivious to your presence.

Mangrove Mountain: farm-fresh goodness and community spirit

Further inland, the rolling hills of Mangrove Mountain reveal a hidden gem – Fanelli Organics. A working farm set on 45 acres, it grows a diverse range of certified organic, seasonal fruit and veggies using regenerative farming practices.

On Sundays, there's a steady stream of locals arriving at the farm stand to pick up their fresh pre-ordered produce boxes. Eden, Fanelli's fourth-generation farmer, and his wife Louise also run on-farm workshops and tours. You can also find the couple at Carriageworks Farmers Market in Sydney every Saturday.

For a taste of local hospitality, The Hub of Mangrove Mountain is a must-visit. This charming community cafe is the heart of the village, where homemade cakes (the cheesecakes are delectable) and locally roasted coffee fuel lively conversations. It's a place where travellers and locals mingle, sharing tales of country life and road trip adventures.

Wisemans Ferry: stepping back in time

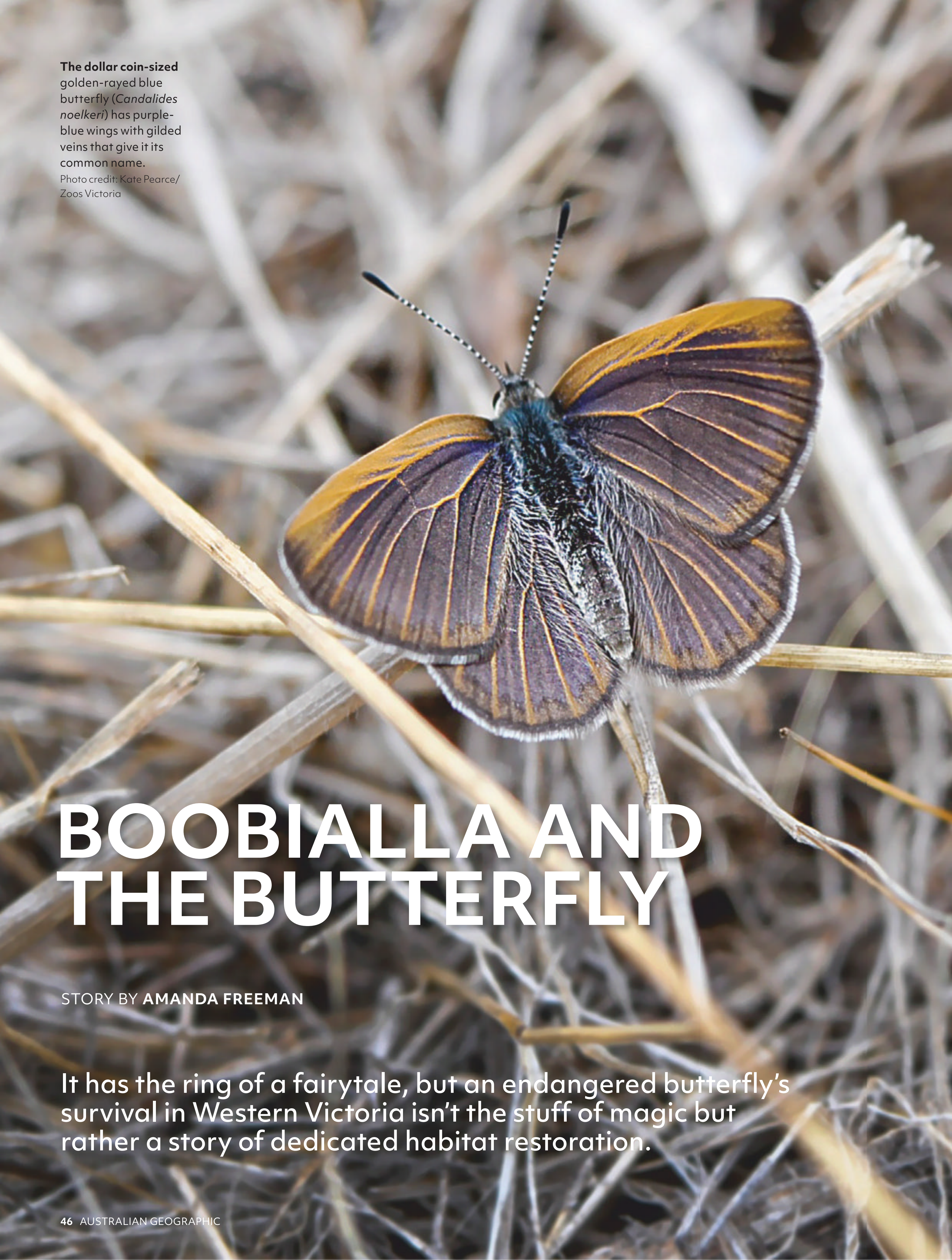
The final leg of my journey brings me to Wisemans Ferry, where history and nature collide. I stretch my legs on Devines Hill loop – part of the Old Great North Road, a UNESCO World Heritage-listed convict-built trail – which passes by towering walls of sandstone that were carved out and engraved by up to 720 convicts between 1826 and 1836. Historic graffiti is etched into the rock face.

The panoramic views of the Hawkesbury River and the spectacular sandstone walls in Dharug National Park make for the penultimate experience on my Central Coast hinterland exploration. Before heading home, I make a stop at The Anchor Spencer. This riverside dining spot, in the historic suburb Spencer, is the perfect place to reflect on the journey. With a plate of freshly caught seafood before me and the Hawkesbury River glistening in the mid-afternoon light, I feel an overwhelming sense of gratitude.

The Central Coast hinterland awaits

Tourist Drive 33 isn't just a road; it's an experience. A place where rugged wilderness meets refined dining, where history whispers through the landscape, and where every stop reveals a new slice of the Central Coast's charm. With its recent ecotourism certification, this hinterland route stands as a shining example of how travel can be both sustainable and unforgettable. Pack your bags, fill up the tank and take the road less travelled. The Central Coast hinterland is waiting. ■

PHOTO CREDITS, CLOCKWISE FROM TOP LEFT: REMY BRAND; JAMES HORAN; JAMES HORAN; ROSS LONG



The dollar coin-sized golden-rayed blue butterfly (*Candalides noelkeri*) has purple-blue wings with gilded veins that give it its common name.
Photo credit: Kate Pearce/ Zoos Victoria

BOOBIALLA AND THE BUTTERFLY

STORY BY **AMANDA FREEMAN**

It has the ring of a fairytale, but an endangered butterfly's survival in Western Victoria isn't the stuff of magic but rather a story of dedicated habitat restoration.

FABIAN DOUGLAS WASN'T expecting a butterfly bonanza at Western Victoria's Lake Wyn Wyn. He and fellow entomologist Frank Noelker had joined birdwatchers there that sunny spring day in 1993, so the focus was on other fauna. Fabian thought, "I won't make a spectacle of myself getting out the net – there's not going to be anything rare here anyway." So he'd set off through the boobialla with binoculars, no butterfly net in hand.

"Then I saw this butterfly go through in the middle distance," Fabian recalls. At first, he assumed it was a common dusky-blue – although out here on the salt lake's flood plain it was a long way from its larval food plant. Common dusky-blue caterpillars nosh on parasitic cassytha vines, but those were some distance back among the eucalypts.

"I'd better get the net," Fabian told Frank. The other birdwatchers looked on in amusement when he went back to fetch it. "Then I saw another butterfly, bolted after it and got it," Fabian says. "The minute I looked in the net, I could see it was different. I looked up and said, 'Hey Frank, we've got a new species.'"

The new-to-science butterfly they'd stumbled upon was the golden-rayed blue, which Fabian and Michael Braby later described and named *Candalides noelkeri* in honour of Frank Noelker, who died in 1996.

Found only in Victoria's Wimmera region where it lives on the fringes of ephemeral salt lakes, the golden-rayed blue depends on creeping boobialla (*Myoporum parvifolium*). The picky species' hungry caterpillars feed on the boobialla's leaves, and the plant's white, star-shaped flowers provide nectar for adult butterflies. "They have a strong preference for the local form of boobialla," explains Fabian, who surveys the species for Zoos Victoria. That's a problem for the endangered golden-rayed blue, because its reliance on the Wimmera's creeping boobialla binds it to the small areas where the low-growing shrub still grows.

Jessie Sinclair, invertebrate conservation coordinator at Zoos Victoria, describes the butterfly's range as a "long, thin band that wraps around the Wimmera lakes and along the Wimmera River". But this unique pocket of Western Victoria is surrounded by broadacre crops such as wheat, barley, lentils and canola. There's not a lot of habitat left for the golden-rayed blue.

Enter Zoos Victoria's Fighting Extinction program and Dalki Garringa Native Nursery, partners in a plan to restore and extend golden-rayed blue butterfly habitat by planting the Wimmera form of creeping boobialla. Where the boobialla goes, they reason, the golden-rayed blue butterfly will follow.

Dalki Garringa – which means 'good growing' in the local Wergaia language – is owned and managed by the Barengi Gadjin Land Council representing Traditional Owners from the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagulk ►

peoples who collectively make up the Wotjobaluk Nations. Located near Wail, about a 20-minute drive north of the regional city of Horsham, Dalki Garringa Native Nursery is staffed by Traditional Owners, workers and volunteers from the surrounding area.

IN ADDITION TO selling food plants and local native species, Dalki Garringa Native Nursery raises creeping boobialla from cuttings of plants growing at the nursery.The nursery's mother plants were themselves grown from cuttings of wild plants known to support golden-rayed blue butterfly populations.

"They propagate really easily because that's their survival mechanism," explains Wotjobaluk woman Elizabeth Mace, the nursery's operations manager. "In a flood, they can just snap and float to the next space, settle into the ground and throw roots within days. Then – *poof!* – up it grows again." This means the nursery can grow and distribute thousands of creeping boobialla cuttings across the Wimmera to support golden-rayed blues.

The nursery takes a lot of pride in growing boobialla for the golden-rayed blue butterfly. "It has given the nursery purpose," Elizabeth says. "We're growing these plants, and they're not just going to sit on a shelf. They're going to their forever home."

In winter 2023, about 2500 of the nursery's boobialla plants found their forever homes in Zoos Victoria's habitat-restoration projects; three sites where new habitat was planted, and three sites boosting boobialla at golden-rayed blue strongholds. Another 2500 plants have been distributed to Landcare groups, communities, schools and interested landholders so they can also plant habitat for the butterfly.

Rainbow Lake, a 75-minute drive from Horsham, is one such place. Just south of Rainbow, where the Wimmera and the Mallee meet, the lake is a decommissioned reservoir that now sports barbecues, a swimming pontoon and campsites. "They've made this community hub, and they welcomed us to put boobialla plants in," Jessie says. "The Wimmera is full of amazing people connected by this common cause of the golden-rayed blue butterfly."

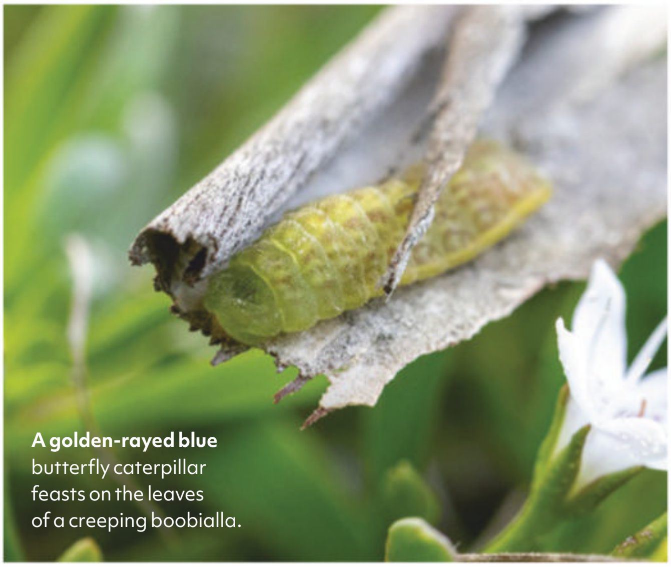
Thousands of zoo visitors have also contributed to the conservation cause, helping fund habitat restoration for the golden-rayed blue by purchasing a 'Totes for Wildlife' bag. Sales of these handy totes fund Zoos Victoria's conservation campaigns, and the butterfly bag was particularly popular. "It's still the best-selling bag we've had," Jessie says. "We sold about 18,000 of them."

Creeping boobialla occurs naturally across southern Australia, and cultivars of the popular native are available throughout the Garden State, sold as hardy and attractive ground covers. But not just any garden-variety boobialla will suffice for the golden-rayed blue butterfly. "If you go and buy plants off the shelf, they could be coming from anywhere," Jessie says. Zoos

The creeping boobialla's star-shaped flowers provide nectar all summer long for golden-rayed blue butterfly adults and a host of other insects.

"That's the thing about butterflies – they can repopulate quickly. Once they're back in there, a female can lay hundreds of eggs."

Jessie Sinclair, invertebrate conservation coordinator at Zoos Victoria, searches for golden-rayed blue butterflies in the ground cover.



A golden-rayed blue butterfly caterpillar feasts on the leaves of a creeping boobialla.

Victoria and Dalki Garringa Native Nursery have produced a label for their plants, identifying them as the Wimmera form, so local gardeners can know which ones will support golden-rayed blues. "In the Wimmera, if you want to grow this plant, [make sure you] plant the wild form," Jessie says.

Home gardens can certainly provide habitat for the golden-rayed blue. "In someone's yard in Horsham, they had big beds of Wimmera boobialla," Jessie says. "That was one of the best survey sites for the butterflies in town. They seemed very happy there."

The creeping boobialla's prolific flowers offer a summer-long nectar source for pollinators. "It's what you might call an ecosystem driver," Fabian says. "Not only does it provide food and nectar for the golden-rayed blue, but its nectar also attracts a whole plethora of butterflies and other insects."

Jessie already sees the boobialla at work in Zoos Victoria's habitat restoration sites, even though they're only a couple of years old. "We're seeing lots of beetles, lots of bees and lots of ants using the plants, as well as lots of different butterflies," Jessie says. "Grass blues are coming through here, as well as grass yellows, common browns and painted ladies." Although golden-rayed blues haven't taken up residence yet, the sites' early success in attracting a variety of butterflies shows that suitable habitat can be re-established.

BOOBIALLA PLANTS ARE well-equipped to tough out extreme weather. "The leaves are fleshy, so they hold on to a fair bit of moisture," Elizabeth says. "And if it's just too much and the top dries out, they've got a fleshy root, so they're able to stay alive until the next rainfall."

Too much rain, however, can flood and kill creeping boobialla plants. "In 2022, the Wimmera had a huge amount of rain," Jessie says. "Lakes filled, the plants died, and when the water receded, there were virtually no boobialla left."

But since then, Jessie and her colleagues have watched the battling boobialla respread. As Elizabeth explains, the creeping boobialla has evolved to live with the ephemeral lake system's strong ebbs and flows.

Those cycles will become more frequent as the Wimmera's changing climate brings increased droughts, bushfires and floods. The Wimmera's boobialla – and the golden-rayed blue butterfly that depends on this plant – will need all the habitat Zoos Victoria, Dalki Garringa Native Nursery and Wimmera landholders and communities can create.

"We're trying to make the habitat more resilient by choosing where we plant," Jessie says. "We'll say, 'Hey, let's put some boobialla a bit out of the flood zone for when the lakes fill, but let's also put some down low for those drought conditions.'"

Four golden-rayed blue butterfly locations were flooded in 2022. The butterflies weren't seen in those locations for two years. Then, in December 2024, Fabian spotted a pair of golden-rayed blues at Lake Hindmarsh.

"We assume that they're just on their way back," Jessie says, obviously relieved. "And that's the thing about butterflies – they can repopulate [quickly]. Once they're back in there, a female can lay hundreds of eggs."

Instead of translocating butterflies, Jessie is relying on the golden-rayed blues to make their own way to newly planted habitat. "If they make their own way, we'll know they can manage these distances," she explains. "It will help with planning habitat restoration in the future."

That future is looking brighter for the creeping boobialla and its butterfly now that habitat restoration is underway. It only needs some golden-rayed blues to cross the gaps. "It didn't happen in 2024, but we're confident they will come," Jessie says. "It's just a matter of waiting and keeping the plants flourishing. It could just take a windy day." ■

PHOTO CREDITS: JO HOWELL/ZOOS VICTORIA

AUSTRALIAN GEOGRAPHIC SOCIETY EXPEDITION REPORT

A LAND SHAPED BY FIRE

STORY BY **DANAH LEARY**

Discover the timeless beauty of Tasmania's ancient landscapes on a 10-day cruising and hiking adventure of the state's southern coastal areas.

Cape Hauy's striking dolerite cliffs rise from the waters near Fortescue Bay.

I WAKE TO the gentle sway of the boat. A rush of excitement pulls me out of my hazy morning dreams as I remember where I am. Drawing back the shutter, I look out at remote South West Tasmania – a place I've always wanted to visit and see with my own eyes. Still, crystal-clear waters reflect the mountains rising from the landscape. The quietness of the scene is beautiful.

I'm lucky to be waking in this special place that rarely sees humans anymore. Yet this is a place steeped in First Nations culture and history, its landscapes shaped over millennia by First Nations peoples.

I'm exploring Tasmania onboard Coral Expeditions' *Coral Discoverer*. We boarded at Hobart last night before setting off on a tour of some of the Apple Isle's most iconic natural sites. This luxury cruise ship will be our base for the next 10 days as we steam around Tasmania's south-western and south-eastern coasts by night and explore its remote and remarkable landscapes by day.

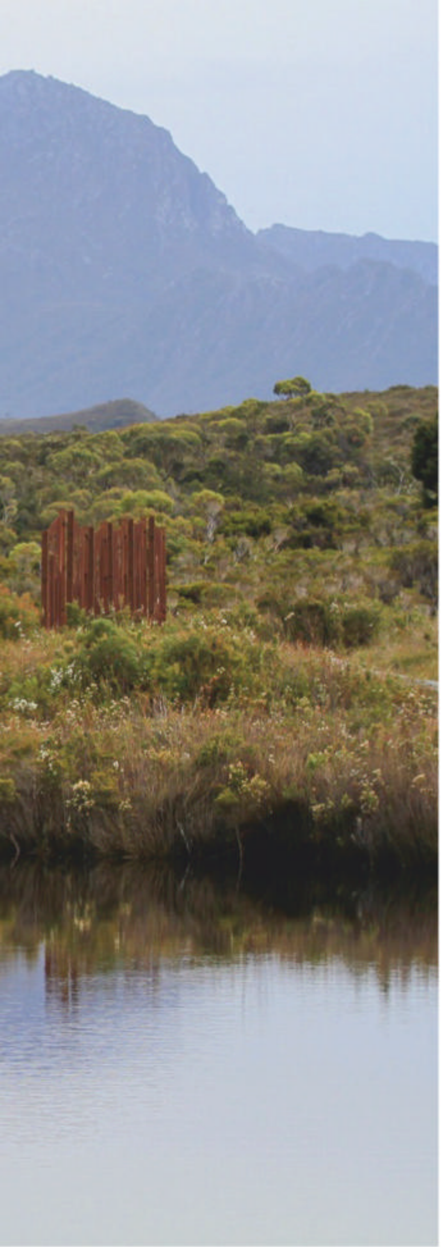
We set off for our first mountain of the trip: Mt Beattie. This beautiful peak rises out of Bathurst Harbour and overlooks Mt Rugby. The rugged Western Arthur Range stands on the horizon. Mt Beattie's quartzite peak is 276m tall and offers expansive views in all directions. The scenery is made all the more impressive by the biodiverse foreground of buttongrass moorlands dotted with flora. Think fan-shaped purple fairies' aprons (*Utricularia dichotoma*) and vibrant-red pygmy sundews (*Drosera pygmaea*), their trichomes glistening in the sunlight like tiny gems. The evolutionary history of these carnivorous plants is as fascinating as their colours and forms.

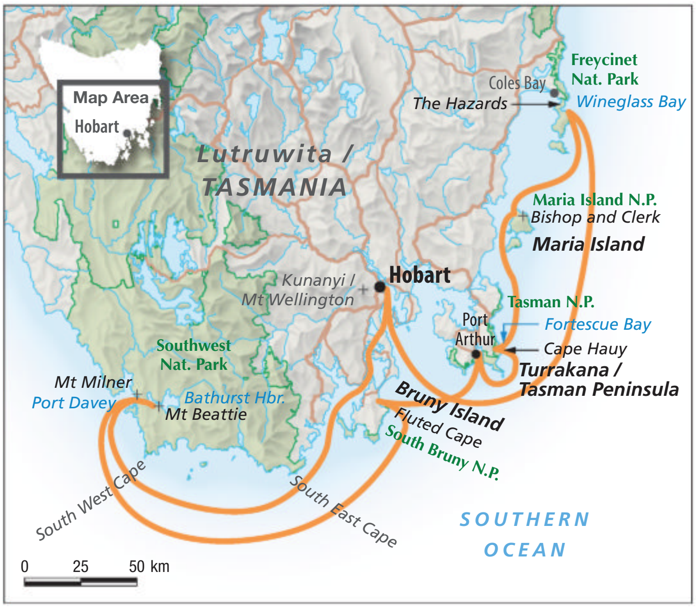
Not long after reaching the top of Mt Beattie I realise how many photos I've taken. As much as my instinct is to capture all these wonders with my camera, I remind myself to stop and be present. In our fast-paced society, it's a special treat to experience a remote wilderness like this.

BODIES TIRED AND minds quiet, we make our way back to the *Coral Discoverer* feeling mesmerised by the mountains that are now perfectly mirrored on tannin-rich Bathurst Harbour. The boat's engines awake, distorting the mountains' reflections in a gentle and hypnotic way. Pure magic.

Over the next few days we explore deeper into the buttongrass moorlands, which are intrinsically connected to the Palawa First Nations people of Lutruwita/Tasmania and, in the Melaleuca and Port Davey areas specifically, to the Needwonnee clan. If only they were here to tell the stories of the land and share knowledge of how to care for this country.

PHOTO CREDITS (INCLUDING PREVIOUS PAGE): COURTESY CORAL EXPEDITIONS





Map Area
Hobart
Lutruwita / TASMANIA
Freycinet Nat. Park
Coles Bay
The Hazards
Wineglass Bay
Maria Island N.P.
Bishop and Clerk
Maria Island
Kunanyi / Mt Wellington
Hobart
Tasman N.P.
Port Arthur
Fortescue Bay
Cape Hauy
Turrakana / Tasman Peninsula
Southwest Nat. Park
Mt Milner
Port Davey
Bathurst Hbr.
Mt Beattie
Bruny Island
Fluted Cape
South Bruny N.P.
South West Cape
South East Cape
SOUTHERN OCEAN
0
25
50 km

We make our way past Permian limestone cliffs filled with ancient marine fossils.

South West Tasmania's Melaleuca–Port Davey area is best explored by river (above).

Fur seals snooze and rest up on Bruny Island (right).

I reflect on how I wish we could still connect with nature in a meaningful way by working alongside it, treating it with respect – at best, even treating it as equal.

One person who heeded the Needwonnee peoples' traditional knowledge was the legendary bushman Deny King. He used patch mosaic burning to manage the landscape, ensuring certain areas were touched by fire at different times. This ancient method of cool burning, or firestick farming, helps sustain the rich biodiversity of Melaleuca's buttongrass moorlands.

This fire management has prompted the return of the orange-bellied parrot (*Neophema chrysogaster*) – one of Australia's most critically endangered bird species – into the area.

The orange-bellied parrot is the world's smallest migratory parrot species. Each summer, it makes its way to Melaleuca's buttongrass to breed. It's a special sight to see these colourful parrots here. Less than 100 are thought to exist in the wild today, and this is where they choose to be.

A SLIGHT HEAVINESS fills me as we leave my new favourite place in Tasmania, but I'm soon reminded the adventure has only just begun.

Our next stop is Bruny Island, an old favourite of mine. Rugged Jurassic dolerite cliffs of the Fluted Cape tower some 270m above the ocean. Centuries-old Tasmanian blue gums ►

(*Eucalyptus globulus*) rise out of the Permian soils at the base of the cliffs. As we wind our way up our scenic hike, the trees soon switch to messmate stringybark (*Eucalyptus obliqua*), with an understorey of spiny-head mat-rush (*Lomandra longifolia*) and sweet bursaria (*Bursaria spinosa*). The sweet bursaria's flowers attract common brown butterflies (*Heteronympha merope*), which weave in and out of our group. We don't need to stop to smell the flowers – the scent flows freely through the crisp morning air.

Witnessing the raw beauty that surrounds us, I realise this is another area equally as rich in threatened species as it is First Nations culture. The connection between the decline of species and the loss of this land's people and culture is glaringly obvious; they are one and the same.

Sailing further east on the *Coral Discoverer*, we pass fish farms nestled in the bays. Mike Sugden, a guest lecturer onboard the *Coral Discoverer*, is a marine scientist, zoologist and avid diver with encyclopaedic knowledge of all things aquatic. He explains the ecological impact of salmon pens on local marine ecosystems.

We sail past Tasman Island and are greeted by fur seals resting on the island's flanks. Albatrosses glide past effortlessly.

Later, when we settle downstairs for dinner, we spot a pod of common dolphins (*Delphinus delphis*) outside the ship's windows. They put on an impressive show for us, surfing and jumping in our wake. It's the perfect end to another unforgettable day.

AFTER VISITING FORTESCUE Bay and World Heritage-listed Port Arthur Historic Site, we explore another incredible island: Maria Island, which brims with both fauna and history.

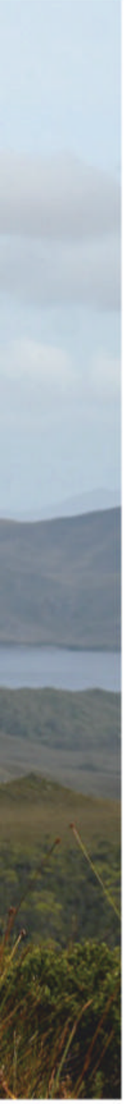
Within minutes of stepping onto the island, we've seen several marsupial and bird species, from Bennett's wallabies (*Notamacropus rufogriseus*) and long-nosed potoroos (*Potorous tridactylus*) to green rosellas (*Platycercus caledonicus*) and yellow-tailed black cockatoos (*Calyptorhynchus funereus*).

When we begin our hike to the summit of Bishop and Clerk, a fluffy wombat greets us on the walking path, its joey visible in the back of its pouch. Welcome swallows (*Hirundo*

Hikers enjoy panoramic views of Bathurst Harbour outside the Claytons Corner homestead.

PHOTO CREDITS: COURTESY CORAL EXPEDITIONS

Visitors explore the ruins at Maria Island, a former penal settlement and probation station.



neoxena) dart in and out of our group as we make our way past Permian limestone cliffs filled with ancient marine fossils. We continue walking towards the dolerite outcrop, which rises 380m above the turquoise ocean below.

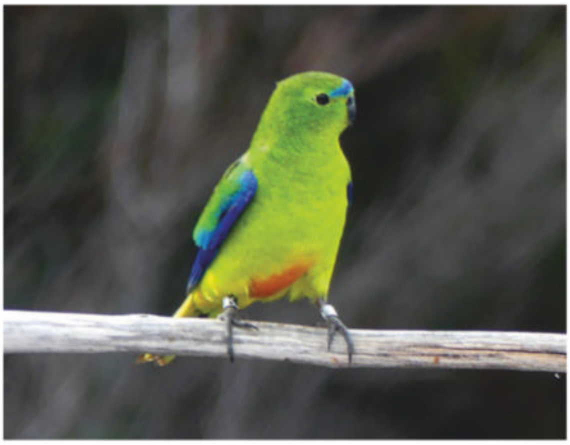
The hike to Bishop and Clerk is spectacular. When we reach the summit, we watch wedge-tailed eagles (*Aquila audax*) soaring below, patrolling the coastline against a backdrop of ancient flora. The 300-million-year-old genus *Cyathea* is sandwiched between two impressive dolerite columns, which are both speckled with lichen.

Time seems to move more slowly at the summit of Bishop and Clerk, surrounded by ancient Gondwanan forests. Thanks to Tasmania's relatively cool climate, ancient Gondwana species have survived in small pockets here, clinging on as the climate shifts. And here on Maria Island they've teamed up with more recently evolved (in the grand scheme of things) eucalyptus forests. It's a haven for native birds, mammals and insects.

What a dream it is to explore so many different wild places along Tasmania's coastline – so full of biodiversity, and lost stories of cultures and history.

Tasmania is a place that needs to be seen and experienced to fully appreciate its beauty. It's so much more than can be captured in images or words; it's a land full of natural wonders and awe-inspiring evolution. This ancient land connects us to the past, and there's much we can learn from what we've lost. But here, at the bottom of the world, these species live on after many millions of years. It's not just a place to visit but also a place to protect. ■

> Tasmania is a place that needs to be seen and experienced to fully appreciate its beauty.



The critically endangered orange-bellied parrot breeds in Melaleuca's buttongrass moorlands.

SPOTTING LEOPARD SHARKS ONCE AGAIN

STORY BY **SARAH REID**

Australian shark experts and aquariums are supporting a world-first conservation project to save the elusive leopard shark in Southeast Asia.

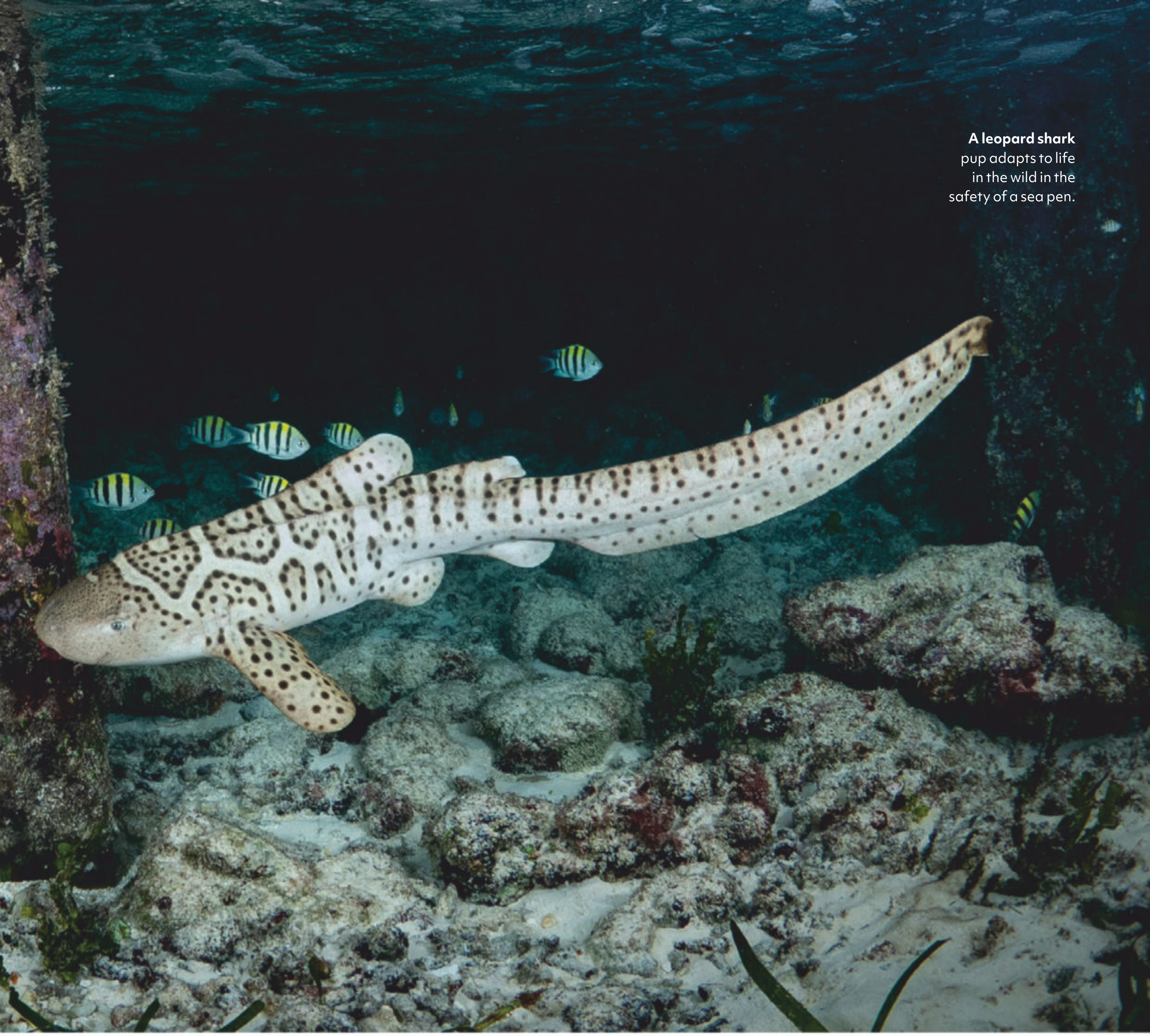
IT'S EASY, AT first, to think the famed reefs of Raja Ampat, in eastern Indonesia's West Papua province, have avoided many of the stresses facing reefs elsewhere. Festooned with colourful corals and teeming with marine life – from fingernail-sized pygmy seahorses to manta rays with the wingspans of small planes – Raja Ampat's reefs offer some of the world's most mesmerising scuba-diving experiences. But there's one sure sign that things are not as they should be: leopard sharks are rarely seen by divers here anymore.

The Indo-Pacific leopard shark (*Stegostoma tigrinum*), also known as the zebra shark, is easily identified by its striking spot pattern and long, slender tail. The species has a wide distribution in the tropical Indo-Pacific. Data collected by ecologist Dr Christine Dudgeon at The University of Queensland and University of the Sunshine Coast shows that they occur across the Indian Ocean and the western and central Pacific Ocean – from South Africa to Samoa and north to Japan.

This leopard shark is often seen swimming languidly among the rocky reefs of northern New South Wales and South East Queensland during the warmer months, where it's thought to breed before heading north to lay eggs on the Great Barrier Reef. The Cape Byron Leopard Shark Project, launched in 2019 by Byron Bay dive operator Sundive, recorded more than 420 individuals in the local Nguthungulli Julian Rocks Nature Reserve in 2023.

But although the species' future is considered stable in Australian waters, that's certainly not the case in Indonesia and beyond. The global population is currently listed as endangered and in decline on the IUCN Red List of Threatened Species.

Like most sharks, the Indo-Pacific leopard shark is harmless to humans. "They're pretty special creatures with a lot of unique aspects to them," says Christine, who has been studying the species for more than 20 years. "They're taxonomically unique, being the only species in their family, the Stegostomatidae, and



A leopard shark pup adapts to life in the wild in the safety of a sea pen.

PHOTO CREDIT: NATHANIEL SOON/RARCC

they're the largest of the egg-laying sharks. Leopard sharks also have the ability to pump water over their gills, allowing them to breathe without swimming."

THE ESTABLISHMENT OF the Raja Ampat Marine Protected Area (MPA) network in 2007, followed by the declaration of the entire region as a shark and ray sanctuary in 2012 – the first of its kind in Southeast Asia – threw a lifeline to shark and ray species decimated by unregulated fishing for the international shark trade. But by then the leopard shark was already functionally extinct locally, with an estimated 20 individuals spread throughout the 6 million hectares of the Raja Ampat archipelago, where jungle-cloaked limestone islands rise from a palette of tropical blues. Between 2001 and 2021, researchers spotted only three during 15,000 hours of searching.

Enter ReShark, an international collective focused on recovering threatened sharks and rays around the world by re-establishing healthy, genetically diverse and self-sustaining populations. ReShark's first conservation initiative, which began in 2020, is called the StAR (*Stegostoma tigrinum* Augmentation and Recovery) project, which aims to repopulate Raja Ampat with leopard sharks using eggs donated by aquariums across the globe.

The origin of the project dates back to 2015, when a reassessment of the shark for the IUCN Red List of Threatened Species, led by Christine, revealed an intriguing conservation asymmetry. "We knew that there were these issues in the wild, but leopard sharks actually seem to breed quite well in aquariums," Christine says.

Initial discussions between Christine and Conservation International's Dr Mark Erdmann (who was then working in Raja Ampat in collaboration with Singapore's S.E.A. Aquarium) about the potential of an ex-situ conservation initiative for leopard sharks gained momentum during the pandemic. Support ►

Profits from the stunning Kri Eco Resort support leopard shark conservation.

came from multiple levels of the Indonesian government, local NGOs, and the IUCN Species Survival Commission (SSC) Shark Specialist Group, helping to make the StAR project a reality. Christine and Mark both sit on its steering committee.

Typically reaching an average length of 2.4m, leopard sharks are commonly kept in Australian aquariums. With three adult leopard sharks (one male and two female) initially identified as genetically suitable to support the project, Sea Life Sydney Aquarium became the project's first breeder institution.

In August 2022, following a lengthy and rigorous approval process, the founder eggs from Sea Life Sydney Aquarium were chaperoned to Raja Ampat by Laura Simmons, regional curator for Sea Life Australia/New Zealand. A few months later, in January 2023, two of the four successful hatchlings – Charlie and Kathlyn – were released at Wayag, an MPA in northern Raja Ampat, before a gathering of government officials including indigenous Kawe people, who manage Wayag. Several celebrity wildlife advocates were also present, including actor Harrison Ford. Female sharks Audrey and Mali were next off the rank, released in February and July 2023 respectively. The release of Claudio in November 2024, one of 12 sharks hatched from 21 eggs donated by Cairns Marine in Far North Queensland, brought the number of pups released in Raja Ampat to 20. Two aquariums in the United States have also donated viable eggs to the project.

Critical to the project are the non-profit arms of two longstanding Raja Ampat dive resort operators: Papua Diving and Misool Resort, which each run an on-site leopard shark nursery. On Kri Island in Raja Ampat, net profits from Sorido Bay Resort and Kri Eco Resort, both run by Papua Diving, support the Raja Ampat Research and Conservation Centre (RARCC).

Juvenile stage
Rewilding zebra sharks
Embryonic stage

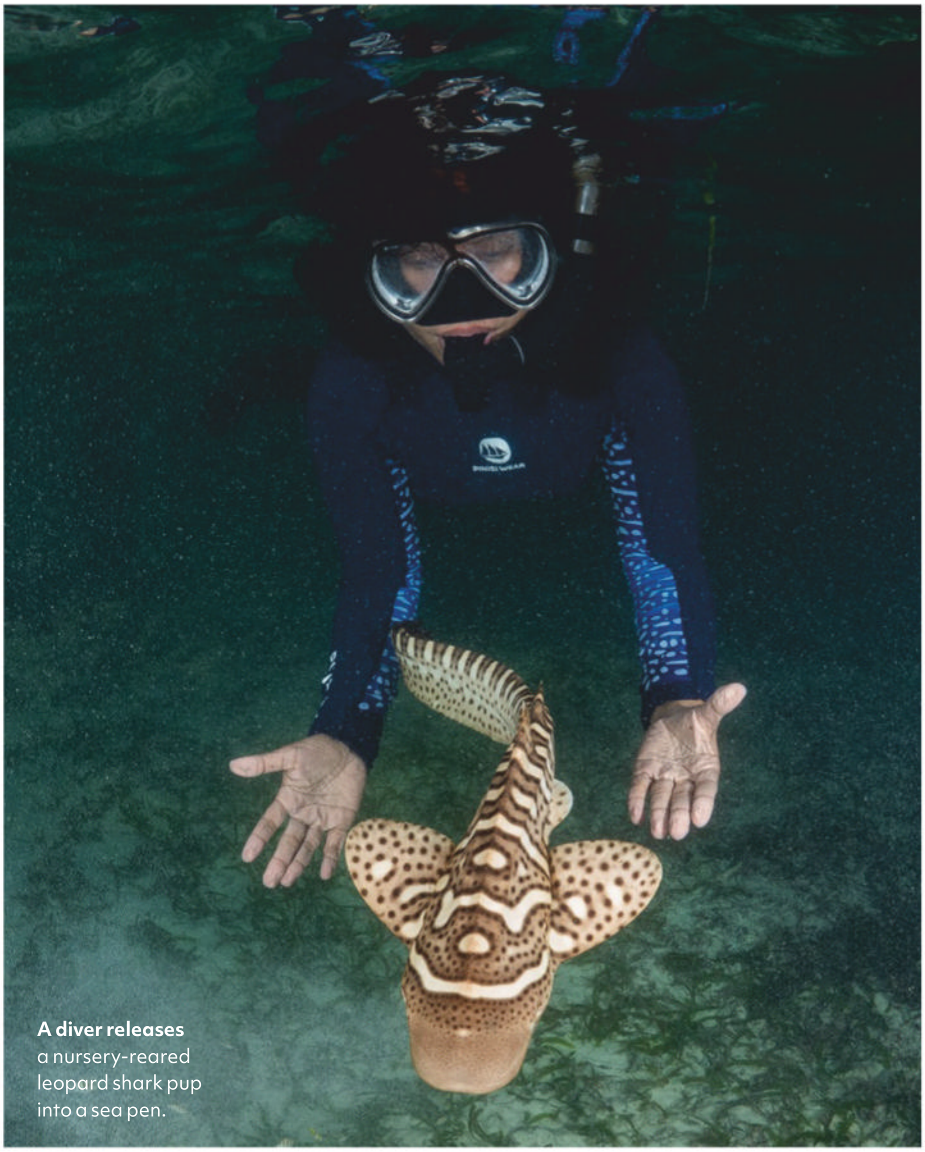
Leopard sharks are reared at Sorido Bay Resort's Raja Ampat Research and Conservation Centre.

AT THE END of a long wooden jetty that meets the edge of the reef at Sorido Bay, a traditional-style thatched hut housing RARCC's leopard shark nursery buzzes with activity as staff monitor tanks housing collections of shark eggs, hatched pups and live leopard shark food including gastropods. Resort guests are welcome to drop in to learn about the project and observe the adorable pups with their zebra-like black-and-cream markings, which slowly morph into the leopard-like spots seen on mature adults.

The juvenile leopard sharks graduate to 'sea pens' as a food source on the local reef to acclimatise to the ocean environment before being released after they've grown to about a metre in length. A second nursery is operated by the Misool Foundation at Misool Resort in southern Raja Ampat.

The pups are fitted with acoustic tags before their release, which, along with sightings shared by local villagers and recreational divers, assists with monitoring. Divers and snorkellers in Raja Ampat are encouraged to contribute by uploading photographs of sightings to the Spot the Leopard Shark website, ▲ *spottheleopardshark.org*.

PHOTO CREDITS, FROM TOP: PAPUA DIVING; SARAH REID



A diver releases a nursery-reared leopard shark pup into a sea pen.

RARCC staff at Papua Diving's Sorido Bay leopard shark nursery (below) monitor hatchlings.

A leopard shark egg case (bottom) is shown to visitors at Papua Diving's Sorido Bay leopard shark nursery.

"In Thailand, the StAR project has led to full species protection being legislated."

An important step in greenlighting the project was a population viability analysis (PVA) conducted by ReShark and the IUCN SSC Conservation Planning Specialist Group, which was informed by data generated throughout Christine's two decades of research. The PVA suggested that the release of 500 individuals during 10 years would establish a healthy, self-sustaining local leopard shark population in Raja Ampat, so there is much work yet to be done.

For StAR project manager Nesha Ichida, a marine conservation scientist from Jakarta with Indonesian environmental group Thrive Conservation, there's never a dull moment on the job. "I could be fixing the plumbing of the nursery one day and dealing with egg shipments or writing grant proposals on another, and then conducting post-release monitoring the next week," she says.

The Raja Ampat community has been essential to the project's success. "This project is only possible because local communities, government, NGOs and private sectors have done the work to protect Raja Ampat properly and get it to a state where other shark species have rebounded," Nesha says. "To be part of a tertiary level of conservation, in a place where we can say that it is better now than it was 20 years ago, is a true privilege for me."

The StAR project, which recently expanded to Thailand with the local activation of the Spot the Leopard Shark citizen science initiative in May 2024, is now catalysing other marine conservation efforts.

"Last year I was invited to present and participate in a workshop with Indonesia's Ministry of Marine Affairs and Fisheries, local government, and shark and ray research and conservation groups to essentially start the process for having leopard sharks fully protected in Indonesia," Christine says. "In Thailand, the StAR project has led to full species protection being legislated."

At a time when global biodiversity is declining at an alarming rate, Christine says the StAR project is like a little beacon of hope: "To have this platform to encourage conservation work at a bigger scale is, to me, really extraordinary." ■

PHOTO CREDITS, CLOCKWISE FROM TOP LEFT: NATHANIEL SOON/RARCC; SARAH REID; SARAH REID

THE MEMORY OF MELBA

STORY BY **LEE MYLNE**

Australia's first A-list celebrity was Dame Nellie Melba, a gifted opera singer with legions of adoring fans across the globe.

SHE WAS THE Taylor Swift of her time, a global singing sensation whose international fame saw her form friendships with royalty and the rich and famous. Nellie Melba's concerts drew thousands, with people lining the streets overnight to secure tickets. Before Beatlemania, there was Melbamania.

When she died in 1931, flags flew at half-mast across Melbourne, the city from which she took her name. National grief for Australia's most famous daughter saw tens of thousands of people line the streets to watch her funeral cortege. A horse-drawn gun carriage carried her casket to Lilydale Cemetery. It was shades of Princess Diana.

But a century after the height of her operatic career, Nellie Melba's name is virtually unknown to young people. Now, a new exhibition celebrating her life is hoping to change that. Running until 29 June, *A Toast to Melba* at Yarra Ranges Regional Museum in Lilydale, Victoria showcases some rarely seen objects, photographs, artwork and personal treasures that help tell the story of this remarkable woman.

"Melba looms large in this area," says exhibition curator Madeline Reece. "What we hope to do is bring her back into the conversation by presenting her as someone younger audiences can relate to. The music may not sway them, but Melba the woman will interest them. What many people don't realise is that Melba was a feminist, a businesswoman and, in many ways, the first 'influencer'. She knew the value of her name as a brand – everything has her initials and signature on it."

Born Helen Porter Mitchell in 1861 to a musical family, Nellie first took to the stage when she was six years old and later studied singing in Melbourne. After the death of her mother, Nellie travelled with her father to Queensland where she met and married Charles Armstrong. Within a year, they had a son, George, but the marriage was not a success; Nellie soon left him.

She later studied in Paris, her pure voice – with a range of three octaves – impressing the renowned vocal teacher Mathilde Marchesi who declared, "I have found a star!"

Taking a stage name that forever linked her to her birthplace, Nellie Melba made her operatic debut in Brussels in 1887 as Gilda in Verdi's *Rigoletto*, before establishing herself as the leading lyric coloratura soprano at London's Covent Garden in the late 1880s. Her fame quickly spread following performances throughout Europe, and in 1893 she debuted at the Metropolitan Opera in New York.

WITH FAME CAME notoriety. Nellie's private life and extravagant lifestyle became tabloid fodder. She was referred to as the 'Queen of Song' and draped herself in furs and glittering jewels both on and off the stage. An affair with the Duke of Orléans in the early 1890s caused a scandal. Her estranged husband threatened to file for divorce unless she allowed him to take their son to America. He then disappeared with George and did not allow him to communicate with Nellie until George was 21. Charles filed for divorce in 1900.

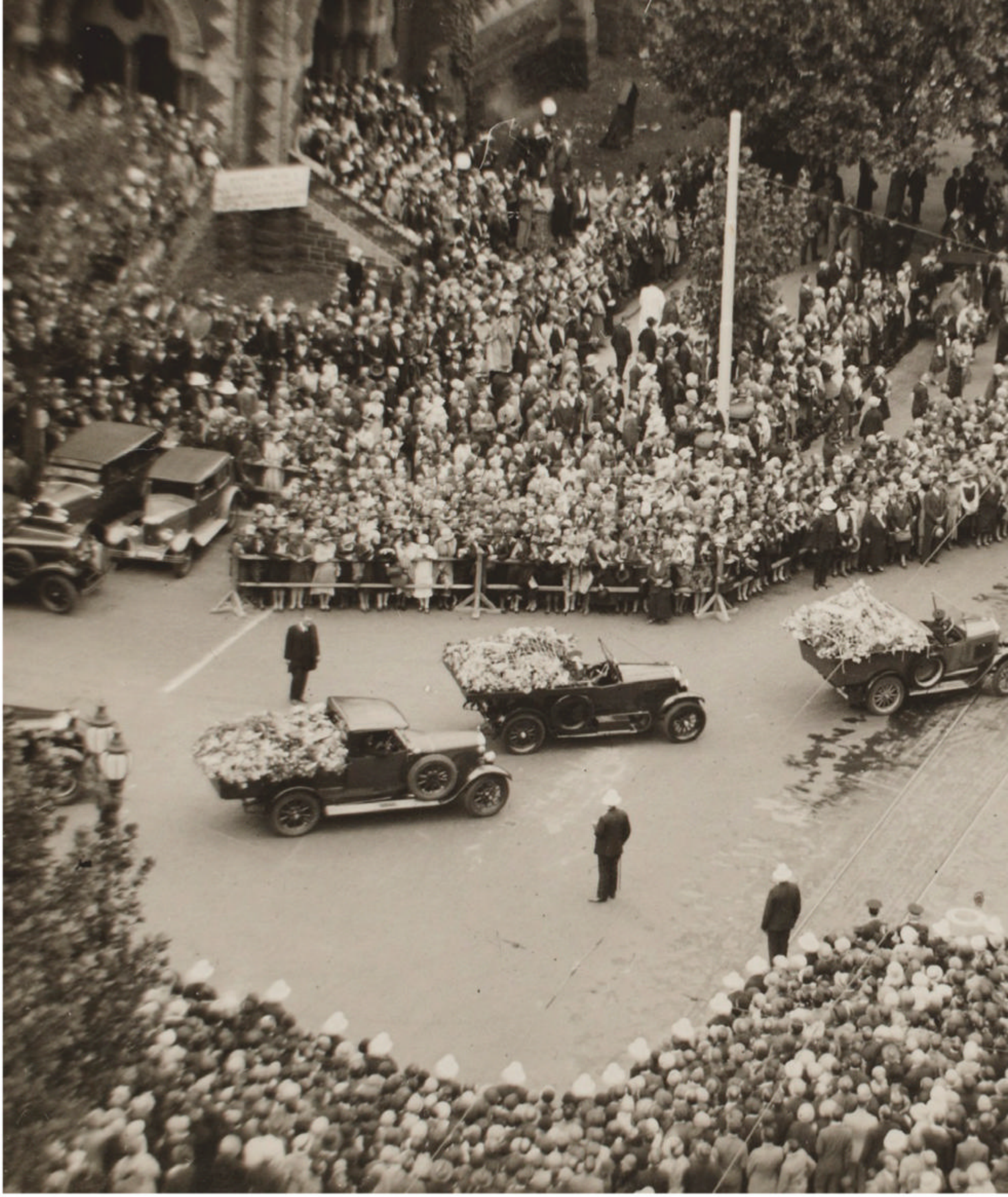
"She was the first Australian to become a worldwide celebrity and her life was widely reported in the newspapers," Madeline says. "But she'd been raised to be an independent woman and she carved out a space for herself and women like her for generations to come. She was a woman who lived life on her own terms."

A Toast to Melba includes costumes, paintings, letters, photos and keepsakes, as well as audio recordings of Nellie singing. "In 1920 Melba was the first person to sing on the wireless radio in ►

By 1905, Nellie was the most famous Australian in the world, feted for her soaring operatic voice and her reputation as a shrewd businesswoman.

PHOTO CREDIT: YARRA RANGES COUNCIL

In February 1931, Nellie's funeral cortege travelled from Scots' Church in Melbourne to her final resting place in the Yarra Valley. Thousands of people lined the streets to watch the procession.



England, and she was among the first recording artists," Madeline says. "She understood the power of [this] new technology."

The exhibition also displays racing silks chosen by Nellie's son George when he registered her membership to the Victorian Racing Club in 1909. Family legend has it that George cheekily chose olive green with a mauve sash and white cap – colours synonymous with the British women's suffrage movement that Nellie supported.

YARRA RANGES REGIONAL Museum, on Castella Street in Lilydale, is flanked by two other places with strong links to the Nellie Melba story.

The Athenaeum Theatre, built in 1888, has a plush Dame Nellie Melba Room with memorabilia and photographs collected by the late founders of the Lilydale Athenaeum Theatre Company, Geoffrey Page and Russell Johnson (some of their collection was donated to the museum). Nellie performed here four times during her career, first in 1909 in a fundraising concert for local community organisations that raised £117 (the equivalent of about $20,000 today).

On the other side of the museum is Melba Park, its entrance marked by two 2.7m-high limestone pillars and gates bearing the monogram DM, a tribute to Nellie's beloved father David Mitchell. The stone gateway and gates were erected in 1928, with Nellie and her granddaughter Pamela laying the foundation stone.

Despite his early reluctance to see his daughter on the stage, David Mitchell was a successful businessman who had instilled in her the importance of being self-sufficient and having her own money, teaching her to be an astute businesswoman.

PHOTO CREDIT: YARRA RANGES COUNCIL

The *A Toast* to Melba exhibition features Nellie's racing silks in the colours of the British suffragette movement.

"She was still considered the greatest singer in the world… She was the ultimate diva."

AS HER CAREER soared, Nellie still called Australia home. In 1902–03 she embarked on a concert tour across Australia and New Zealand.

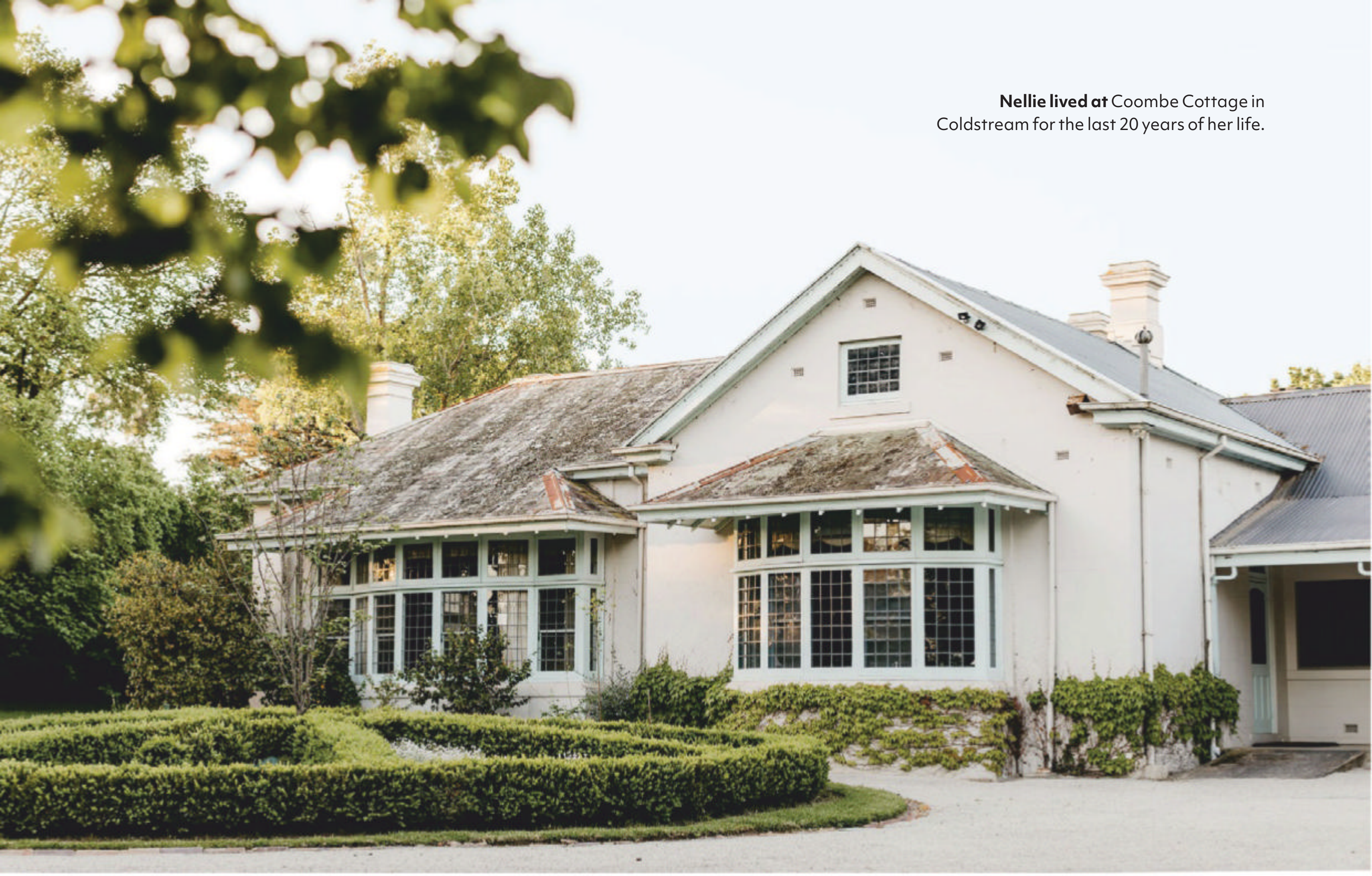
In 1909 she bought an old farmhouse and 60 acres at Coldstream, just outside Lilydale. The house, which she named Coombe Cottage, remains in the ownership of her descendants and is still a family home (albeit one that's open to the public).

Guided tours of the house and its expansive garden are led by historian Courtnay Lucas. The tour begins near the former garages that housed Nellie's cars. "Divas didn't drive," quips Courtnay. "But Melba had a vast collection of cars. We know they included a Pierce-Arrow, a Renault, a Cadillac, a Rolls-Royce and a Fiat."

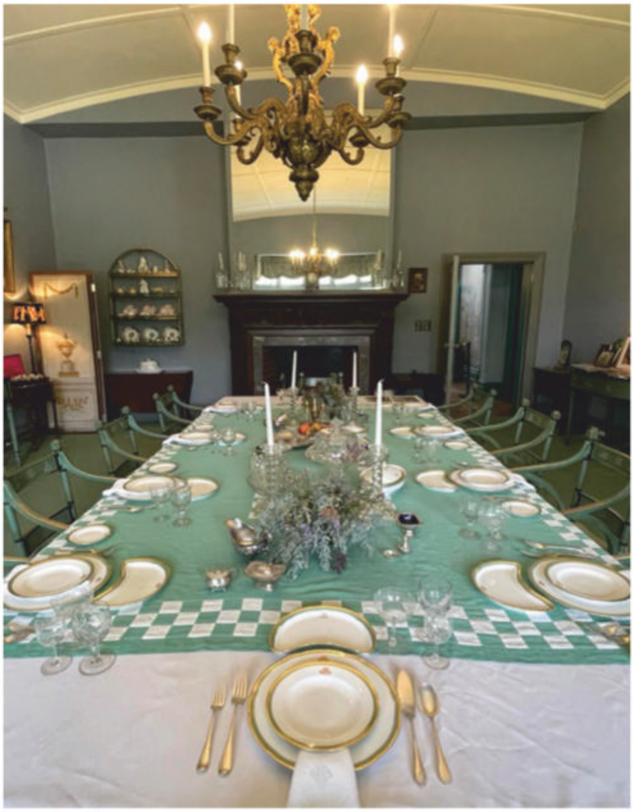
The driveway, with its avenue of elms, leads to the original 2.8ha of garden, dominated by a massive English oak and ►

PHOTO CREDIT, FROM TOP: SEAN PARIS PHOTOGRAPHY; LEE MYLNE

Stone pillars flank the entrance to Melba Park in Lilydale.



Nellie lived at Coombe Cottage in Coldstream for the last 20 years of her life.



"I have built my Australian home, Coombe Cottage, almost within sight and sound of the same trees and vineyards in which I played as a child, under the same brilliant sunshine, facing the same sudden storms that sweep in...from the hills... If you wish to understand me at all...you must understand, first and foremost, that I am an Australian."
– Dame Nellie Melba, 1925

Coombe Cottage features an elegant dining room (above) with a table set with monogrammed cutlery, crockery and linen. The cottage is surrounded by a beautiful garden, including an avenue of elms (right).

PHOTO CREDIT, CLOCKWISE FROM TOP: ANITRA WELLS; ANITRA WELLS; LEE MYLNE

divided into sections including a French rose garden, English herbaceous borders, vegetable gardens and an Italian garden with Roman bath. It's encompassed by towering cypress hedges and was designed by William Guilfoyle, the renowned architect of Melbourne's Royal Botanic Gardens. Guests arrived from Melbourne by private train for Nellie's lavish garden parties.

In June 1911, Nellie attended the coronation of King George V and Queen Mary as one of the honoured guests (and a personal friend) and later that year returned to Australia, where she lived at Coombe Cottage – when not performing overseas – with her son George, his wife Evie, and their daughter Pamela.

Coombe Cottage was Nellie's home for the last 20 years of her life and is a delightful time capsule of that time. With the help of architect John Harry Grainger, father of the composer Percy Grainger, Nellie created an expansive family home with nine bedrooms and six bathrooms.

Visitors can see her lavish dining room (with monogrammed linen, crockery and cutlery), library, kitchen, bedroom, and the grand music room where she hosted parties. Nellie's love for chinoiserie is clearly displayed through porcelain vases and figurines to Chinese robes and Japanese kimonos.

Nellie lived at Coombe Cottage during World War I, when she worked tirelessly to raise money for war charities, hosting knitting parties and other fundraisers at her home. In 1915 she published *Melba's Gift Book of Australian Art and Literature*, with contributions by leading Australian artists, poets and writers that raised funds for the Belgian Relief Fund – her thanks to the country that first embraced her talent. The book sales raised £100,000 – the equivalent of about $12 million today.

Nellie Melba
1894

100
ONE HUNDRED DOLLARS
Australia

Nellie performing as Marguerite in *Faust* in 1894 (above). The diva's portrait has featured on the Australian $100 banknote (left) since 1996.

Nellie also held charity concerts and sold signed memorabilia to help the war effort. For her services, she was made a Dame Commander of the Order of the British Empire in 1918.

During this time, she also established a singing school at the Melbourne Conservatorium of Music in Albert Street, later renamed the Melba Memorial Conservatorium of Music, providing her services free of charge.

Her career was not yet over, but by 1926 she announced her intention to retire from the stage and gave a number of 'farewell' performances – leading to the Australian idiom 'doing a Melba'. Her final Covent Garden performance was in 1926. In 1927, she sang at the opening of Parliament House in Canberra, and was made a Dame Grand Cross of the Order of the British Empire, the first commoner to receive the award. That year, she also became the first Australian to appear on the cover of *Time* magazine.

Nellie's final concerts took place in Australia in 1928. By then she had become a cultural icon, featuring on postage stamps, cigarette cards and later, from 1996, on the Australian $100 note. Even those with hazy knowledge of her career may know of peach Melba, the dessert of peaches with raspberry sauce and vanilla ice cream, created in her honour by acclaimed French chef Auguste Escoffier in 1893 at London's Savoy Hotel. The occasion was the premiere of the Italian opera *Pagliacci* (The Clowns) – and coincidentally Nellie's 32nd birthday.

IN 1931 NELLIE died from septicaemia at St Vincent's Hospital in Sydney. She was 69 years old. The diva's final resting place is at Lilydale Lawn Cemetery.

"After her death, Melba lay in state at Scots' Church Melbourne, before her cortege travelled east to Lilydale," says Maria McCarthy, president of the Lilydale & District Historical Society. "At the town's band rotunda her coffin was put onto a horse-drawn carriage for the final journey to the cemetery."

Nellie's gravestone is of military style, designed by British war-memorial architect Sir Edwin Lutyens in recognition of her significant contribution to the war effort.

But the diva's gravestone is dwarfed by the memorial that's next to it, erected by Nellie in memory of her parents and three of her siblings.

One of Nellie's most celebrated roles was that of Mimi in Puccini's *La bohème*. It seems fitting that etched into her gravestone are the words 'Addio, senza rancor' (farewell without regret), a line from Mimi's farewell. ■

Lee Mylne travelled with support from Yarra Ranges Tourism and Coombe Yarra Valley and stayed in the Yarra Valley as a guest of Araluen Lodge, Yarra Glen.

PHOTO CREDIT, FROM TOP: YARRA RANGES COUNCIL; ALAMY

Australia is home to more than 250 native frog species, including this red-eyed tree frog (*Litoria chloris*).
Photo credit: Jasmine Vink

IT'S NOT EASY BEING GREEN

STORY BY **ESME MATHIS**

As well as suffering the same range of threats facing animals worldwide, our frogs continue to battle a deadly fungal disease.

WHEN AUSTRALIA'S NATIONAL threatened species list was updated in March, almost a third of the newly listed animals were frogs. With the additions of the Mount Ballow mountain frog (*Philoria knowlesi*), giant burrowing frog (*Heleioporus australiacus*) and the southern giant burrowing frog (*Heleioporus australiacus flavopunctatus*) to the Environment Protection and Biodiversity Conservation Act List of Threatened Fauna, Australia's number of threatened frog species has now risen to 53. Given there are more than 250 known frog species in Australia, that means about 20 per cent of our native frog species are at risk of extinction.

It's no secret frog populations worldwide are in decline, impacted by a cocktail of threats including habitat loss and modification, pesticides, pollution, invasive species and climate change. But a major driver of what's becoming known as an 'amphibian apocalypse' is a highly infectious disease called chytridiomycosis (also known simply as 'chytrid'). Caused by the fungus *Batrachochytrium dendrobatidis* (Bd), this pathogen can kill a frog by damaging the keratin layer in its moist skin, affecting its ability to absorb water, regulate electrolytes and respire. This loss of function can lead to cardiac arrest.

Thought to be native to the Korean peninsula – where local frog populations seem to be immune to the pathogen – this chytrid fungus has spread to every amphibian-inhabited continent in the world via the global wildlife trade and is now found in more than 60 countries. So far, it's known to have caused the extinction of at least 90 amphibian species worldwide and has been the leading cause of decline in 500 more.

In Australia, amphibian chytrid has contributed to the decline of 43 native frog species and driven at least four to extinction. Scientists and conservationists are still working to understand the full impact chytrid has had on Australia's threatened frog species because long-term population data is rarely available. But fieldwork and population surveys, public reports of frog die-offs such as the 2021–2022 mass events on Australia's east coast, and data accrued from citizen-science initiatives such as FrogID paint a pretty clear picture. Australia's frogs are in trouble.

THE AMPHIBIAN CHYTRID fungus likely arrived in Australia in the 1970s and has since spread to every state and territory except the Northern Territory. It's now found along the Great Dividing Range on Australia's east coast (including the Australian Capital Territory), as well as south-eastern South Australia, central and eastern Tasmania and south-western Western Australia.

A frog can contract chytrid if it's exposed to water contaminated with Bd spores, or through direct contact with an infected frog or tadpole. (It can also cure itself of the disease by baking off the infection in a warm area; the fungus will die if it's exposed to temperatures above 37°C for more than four hours.)

As with any disease, there are several factors that affect its severity. "A frog that's infected with the amphibian chytrid [might not] instantly get sick and die," says Dr Jodi Rowley, curator of amphibian and reptile conservation biology at the Australian Museum and conjoint associate professor at the Centre for Ecosystem Science at the University of New South Wales. "It's got a lot to do with what species it is and their inherent immunity, but also a lot to do with what environment it's in."

The fungus zoospores spread through water or soil, so species that live near permanent water sources such as ponds and streams have a greater risk of contracting the disease. That also means male frogs are more susceptible to contracting the disease than females. "Male frogs tend to hang out around water more often because they're calling for their females," Jodi says. "Whereas female frogs generally – not always, but generally – don't want to go near a water body unless they want to breed, because males will just annoy them."

The amphibian chytrid fungus thrives in cool, wet environments. It's less virulent in warm, dry areas, and won't grow at temperatures above 28°C. Because of this, chytrid outbreaks are often seasonal. "I'll survey frogs in summer, and often I won't find any frogs – or very few frogs – that have the amphibian chytrid fungus," Jodi says. "But if I go back in the middle of winter to the same place and the same species, often there'll be quite high infection prevalence."

It also means highland frog populations tend to be more severely impacted than lowland populations. The Australian lacelid (*Litoria dayi*), for example, was once a common fixture in the Wet Tropics of Queensland, with an altitudinal range that spanned from sea level to the slopes of Mt Bartle Frere (1622m). Now, chytrid has restricted the species' range to rainforests below 400m, where warmer temperatures help keep the fungus at bay. ►

PHOTO CREDITS, BELOW: COURTESY DR ANTHONY WADDLE; RIGHT: ESTHER BEATON

In Australia, chytrid has contributed to the decline of 43 native frog species and driven at least four to extinction.

(Above) Frogs can contract chytrid by swimming in water contaminated with Bd spores.

Green and golden bell frogs (*Litoria aurea*) shelter inside a frog sauna at Sydney Olympic Park (left) to keep warm and fight off infection.

One of the hardest-hit species is the southern corroboree frog (*Pseudophryne corroboree*). Found only in Kosciuszko National Park, this critically endangered species dwells in subalpine woodlands and montane forests in the NSW Snowy Mountains. In 2014 it was estimated fewer than 50 individuals remained in the wild, but captive-breeding programs have salvaged this brightly coloured frog from extinction. Thanks to Taronga Zoo, Melbourne Zoo, Healesville Sanctuary and the Amphibian Research Centre, more than 2000 frog eggs have been released at Kosciuszko National Park to boost its wild population. There's also a captive-breeding program for the critically endangered northern corroboree frog (*Pseudophryne pengilleyi*); staff at Tidbinbilla Nature Reserve, Taronga Zoo and Healesville Sanctuary have bred and released more than 2000 eggs in the Brindabella Range on the ACT–NSW border.

The fungus's intolerance of warm weather also raises interesting questions about how the disease might respond to climate change. "After the cyclones in North Queensland bashed down a lot of the trees and let more sunlight into the canopy, there was some preliminary evidence [that] the frogs actually did better because they could get warmer and drier because of the sun," Jodi says. "Bushfires could potentially have the same effect. By opening up the canopy, the frogs can then get nice and warm and get rid of the amphibian chytrid fungus. Or maybe the frogs are just hideously stressed because they've gone through a bushfire and their immune system goes down, so they get worse."

Attempting to eradicate amphibian chytrid from Australian ecosystems is a fool's errand as the fungus is so widespread, so conservationists are now focusing on managing other threats and breeding healthy insurance populations. "Unfortunately, I don't think we're going to be able to get rid of it," Jodi says. "You can do some small things to tip the favour towards the frogs and away from the disease, but it's really about managing other threats so that the frogs can hopefully live with it and maybe even bounce back."

"There are so many potential applications now for genetic modifications...it's a bit of a no-brainer in terms of the benefits."

A scientist swabs a green and golden bell frog to test for amphibian chytrid. The disease can be cured in the lab with antifungal treatment.

Insurance populations are being bred in conservation breeding programs across Australia. In addition to the southern and northern corroboree frogs, targeted species include the Kroombit tinker frog (*Taudactylus pleione*), bred by Currumbin Wildlife Sanctuary in Queensland; spotted tree frog (*Litoria spenceri*), by Zoos Victoria; and Booroolong frog (*Litoria booroolongensis*), by Taronga Zoo in Sydney. Other threats to manage include climate change – leading to more frequent extreme weather events such as bushfires, droughts, storms, floods – as well as habitat loss and modification, pollution and pesticides, predation or competition with introduced species, and other diseases such as ranaviruses.

"Trying to understand how the amphibian chytrid fungus interacts with all these other threats is really important, because increasingly with climate change, we're not just going to be dealing with one threat – we're going to be dealing with all these kind of synergistic effects, one on top of each other," Jodi says.

IN A LABORATORY at The University of Melbourne, geneticist Dr Stephen Frankenberg is researching ways to genetically engineer frogs' immune systems against chytrid. It's an ambitious project that sounds like science fiction, but recent breakthroughs in gene editing and immunology have placed it in the realm of possibility.

Stephen and his team are working with transgenes, which are genes taken from one organism, engineered, then inserted into another. "The idea is to have a transgene that you can just knock into the genome that will provide some sort of degree of immunity as a first line of defence [against chytrid] – just enough to tip the scales in favour of the frog species," Stephen says.

Surprisingly, the transgene in question isn't derived from amphibians but from camels and alpacas. Stephen says members of the Camelidae family produce nanobodies – tiny, specialised antibodies – that are particularly suited to the job. Supported by a $3 million grant from the Colossal Foundation, the Texas-based biotechnology company best-known for its ongoing efforts to 'de-extinct' the woolly mammoth, Stephen and his team are now screening those nanobodies to identify which ones have an affinity with chytrid and can neutralise the pathogen.

The project is still in its early days, so Stephen can expect some unexpected hurdles ahead. One major focus is ensuring the transgene won't have any inadvertent side effects. "It's important to make sure that you're putting it into a part of the genome where it's not going to affect the expression of any other genes and have any negative impact," Stephen says. "You don't want that frog to be slightly less fit than it would have been otherwise…even if the benefit from the immunity is greater than the disadvantage from that other effect."

Stephen and his team are currently using cane toads (*Rhinella marina*) as their lab model. Testing the transgene in frogs won't happen for another two or three years, but Stephen already has a few species in mind that he'd like to target, including the green and golden bell frog and corroboree frog. Then, it's a matter of testing the fitness of those frogs and breeding them up for release.

PHOTO CREDIT: YORICK LAMBREGHTS

Amphibian chytrid has contracted the range of the waterfall frog (*Litoria nannotis*) in the Wet Tropics of Queensland.
Photo credit: Bridgette Gower

In the face of the amphibian apocalypse, genetically modified frogs might be just the ticket. The concept of genetically modified wildlife is still new enough to make the public feel squeamish, but Stephen believes people will come around to the idea when they realise it can be used as a force for good. "Because of the progress of technology, there are so many potential applications now for genetic modifications for the purpose of conservation," he says. "It's a bit of a no-brainer in terms of the benefits.

"We've seen it happen in the past with technologies that seem, at face value, scary to many people, but then people get used to it," he says, citing IVF and genetically modified foods as an example. "They're far less demonised now than they were a couple of decades ago. People just get used to the idea."

THERE'S NO SILVER-BULLET solution to managing amphibian chytrid, but there are small things we can do to give frogs a fighting chance. Dr Anthony Waddle is a conservation biologist at Macquarie University who developed a simple yet effective solution to mitigating outbreaks in urban areas: frog saunas.These purpose-built shelters provide frogs with a warm place to raise their body temperatures and stave off the disease.

Aware that many frogs are well-adapted to urban environments and sheltering in artificial habitats such as letterboxes, toilets and masonry bricks, Anthony devised a way to repurpose these materials to create a humid, muggy environment where a sick frog can keep warm and bake off its infection. These 'frog saunas' are essentially piles of masonry bricks painted black to trap in the heat and covered by a greenhouse to keep them warm and humid. The DIY thermal shelter costs about $40 to make and uses materials readily available at Bunnings: a small drop-over greenhouse, 10-hole clay masonry bricks, black paint and cable ties. "It's nothing super high-tech, but it works really well," Anthony says.

Frog saunas have already been rolled out at Sydney Olympic Park to support its green and golden bell frog population. "There are these areas in Greater Sydney and within the city where there are frogs [and] frog ponds. And these [habitats] have been built, but there's chytrid there. When the winter comes around, there's a lot of mortality," Anthony says. He plans to build about 100 more frog saunas throughout Greater Sydney this coming year, but hopes to one day roll out saunas in urban areas across the species' entire range. He has also done workshops in the ACT – where the green and golden bell frogs are being reintroduced – and freely emails out his DIY sauna construction guide to anyone looking to build one in their backyard.

Building frog saunas is just one way to support local frog populations. Anthony says that just making your garden more frog-friendly – planting natives, reducing chemical pesticides and keeping predatory pets indoors – will also make a difference. "The urban environment doesn't need to be just for cars and concrete," he says. "You can create natural landscapes and you can futureproof them using [plants] that are native, that are resilient to climate change, and build frog ponds. And this does make a massive difference. If you start planting native trees you'll get more birds, and if you create little water ecosystems, like a little pond, frogs will come to it." ■

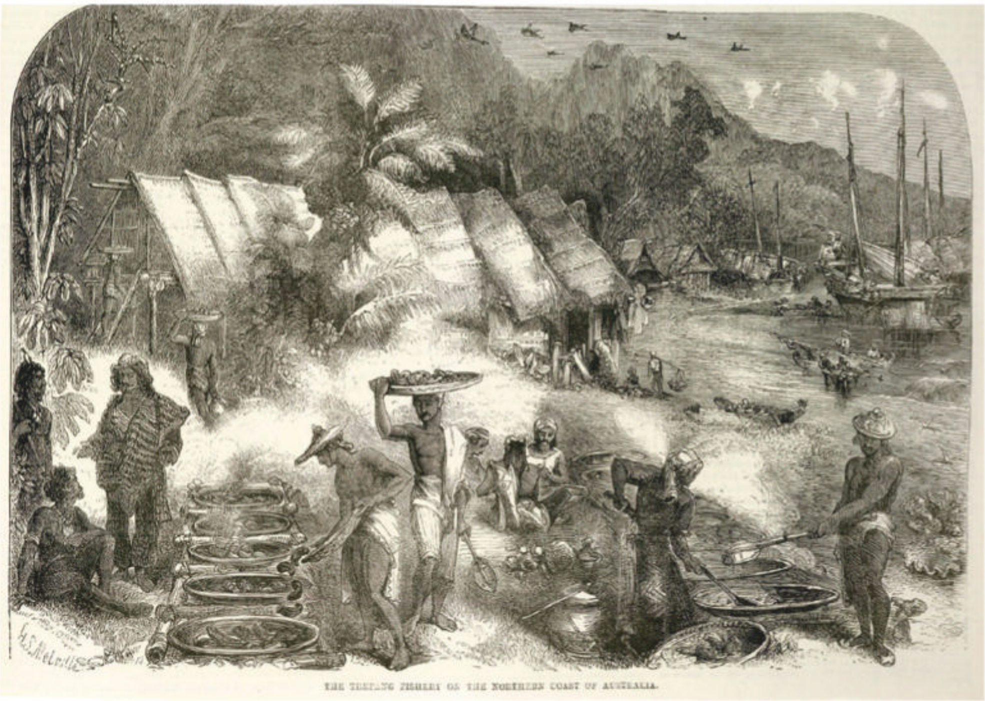
AUSTRALIA'S OLDEST EXPORT

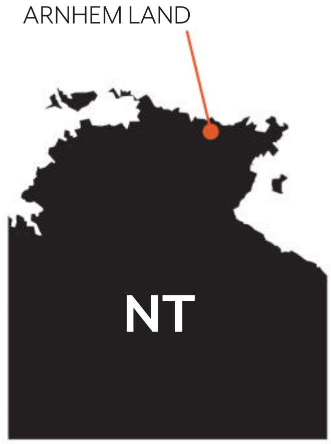
STORY BY **CAROLYN BEASLEY**

Dive into the realm of the sea cucumber, an unassuming creature that helped shape Australia's pre-European culture.

A diver from Tidal Moon harvests a surf redfish sea cucumber in Shark Bay.

This 1862 illustration depicts a bustling trepang fishery on the northern coast of Australia.


THE TREPANG FISHERY ON THE NORTHERN COAST OF AUSTRALIA.



AT CERTAIN POINTS along the wild and unspoilt coastline of the Northern Territory's Arnhem Land and Western Australia's Kimberley, tamarind trees provide shade from the blistering sun. The trees aren't native, and yet they've been here for centuries.

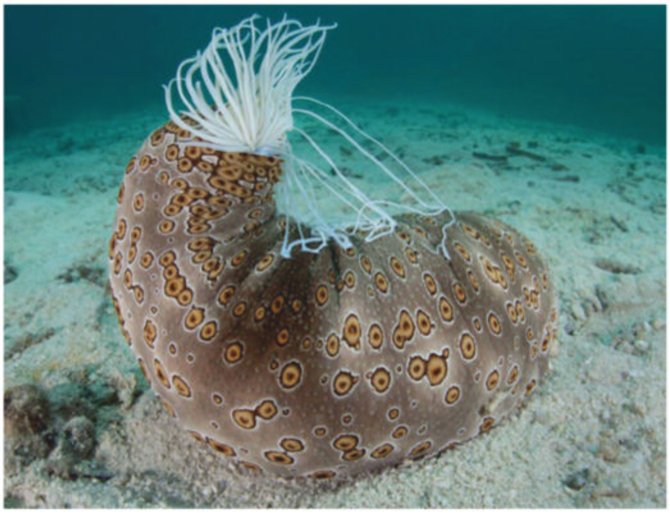
The answer to this riddle is that they were planted here by what were most likely Australia's first outside visitors. It wasn't the British, the French or even the Dutch, but traders from the port of Makassar on the island of Sulawesi in present-day Indonesia.

The traders came seeking sea cucumbers, which they dried into a product called trepang or bêche-de-mer. And they brought more than just the tamarinds. First Nations peoples interacted with the Makassans, exchanging language and dugout canoes, and even intermarrying. They were involved in international trade well before the European world really knew where Australia was.

TO UNDERSTAND THE significance of the sea cucumber trade, it's useful to first understand the animal. Definitely not sea slugs, they are members of the echinoderm group, making them related to sea stars and sea urchins. They're typically cylinder-shaped with five rows of tube feet operated by a water vascular system. Interestingly, the anus not only discharges waste but is also used for breathing.

There are more than 1000 species of sea cucumber worldwide. At least 160 species live in Australian waters. And in deep-sea environments, many new species are still being discovered. "I know of at least four new species that have been described already this year," says Associate Professor Zoe Richards, curator of marine invertebrate zoology at the Western Australian Museum.

Some sea cucumbers have evolved with surprising habits. The black sea cucumber (*Holothuria leucospilota*) can shoot sticky threads from its anus in defence, while the leopard sea cucumber (*Bohadschia argus*) often has a tiny pearl fish residing inside its anus. Zoe says her favourite is the swimming sea cucumber (*Enypniastes eximia*), which lives in the deep sea. "It was given the unfortunate common name of 'headless chicken monster' by the scientists who first observed it swimming," Zoe says. "It has large paddle-like fins which help it swim, but they thought its 'wings' made it look like a headless chicken flapping around."



A leopard sea cucumber projects its Cuvierian tubules – sticky, toxic threads that are expelled in self-defence.

Quirky habits aside, sea cucumbers provide habitat for hitchhiking crabs and molluscs, and food for animals such as flatback turtles. They also play a vital ecosystem role. "They consume sediment, which keeps the sea floor clean and suppresses diseases that may otherwise infect corals or fishes," Zoe says.

Sea cucumbers were (and still are) a delicacy in China, where they are prized for their nutritional and medicinal properties. So lucrative was the early trepang industry that fishermen made the perilous journey to northern Australia from Makassar, sailing in wooden, single-hull ships known as praus (or prahus).

PHOTO CREDIT, THIS PAGE, FROM TOP: THE QUEEN ILLUSTRATED JOURNAL AND REVIEW LONDON 1862; ALAMY. OPPOSITE PAGE: COURTESY TIDAL MOON/GIACOMO D'ORLANDO. PREVIOUS PAGE: GIACOMO D'ORLANDO

The journey took place around December each year, harnessing the north-west monsoonal winds. The fishermen would spend about three or four months living in northern Australia, where they would collect and dry sea cucumbers along with shark fins, pearl shells, shark meat, turtle shells and trochus (sea snails). When the winds changed, they would sail home with their catch.

They came in large numbers. In 1803 navigator Matthew Flinders recorded in his journal that he'd encountered a Makassan captain named Pobassoo who said he was part of a larger fleet of 60 praus carrying about 1000 men. Arnhem Land is the best-documented destination for Makassan visitors, and First Nations communities here have an uninterrupted oral history of the visits that continue today.

DISTINGUISHED PROFESSOR LYNETTE Russell of Monash University is the chief investigator of the project *Global Encounters and First Nations Peoples: 1000 Years of Australian History.* She and her colleagues have documented many stories of Makassans in the NT, including interactions with communities from Elcho Island, Groote Eylandt and the Gulf of Carpentaria coast. Lynette says that although these vessels originated from the port of Makassar, the people sailing on them were of many ethnicities including Makassarese, Buginese, Butonese, Bajau and potentially Javanese. The Makassan trepangers also visited the Kimberley, although the extent of the trade is less well-known.

Dr Corioli Souter, head of maritime heritage at the Western Australian Museum, has worked on archaeological digs in the Kimberley, furthering work that began in the 1960s. Her work near Kalumburu is part of the joint management of the North Kimberley Marine Park with the Kwini Balanggarra and Wunambal Gaambera people in cooperation with the WA Department of Biodiversity, Conservation and Attractions.

"Our excavations were in 2019 and 2021, and a lot of the Elders came down looking at our material," Corioli says. "They're working with our results as well.

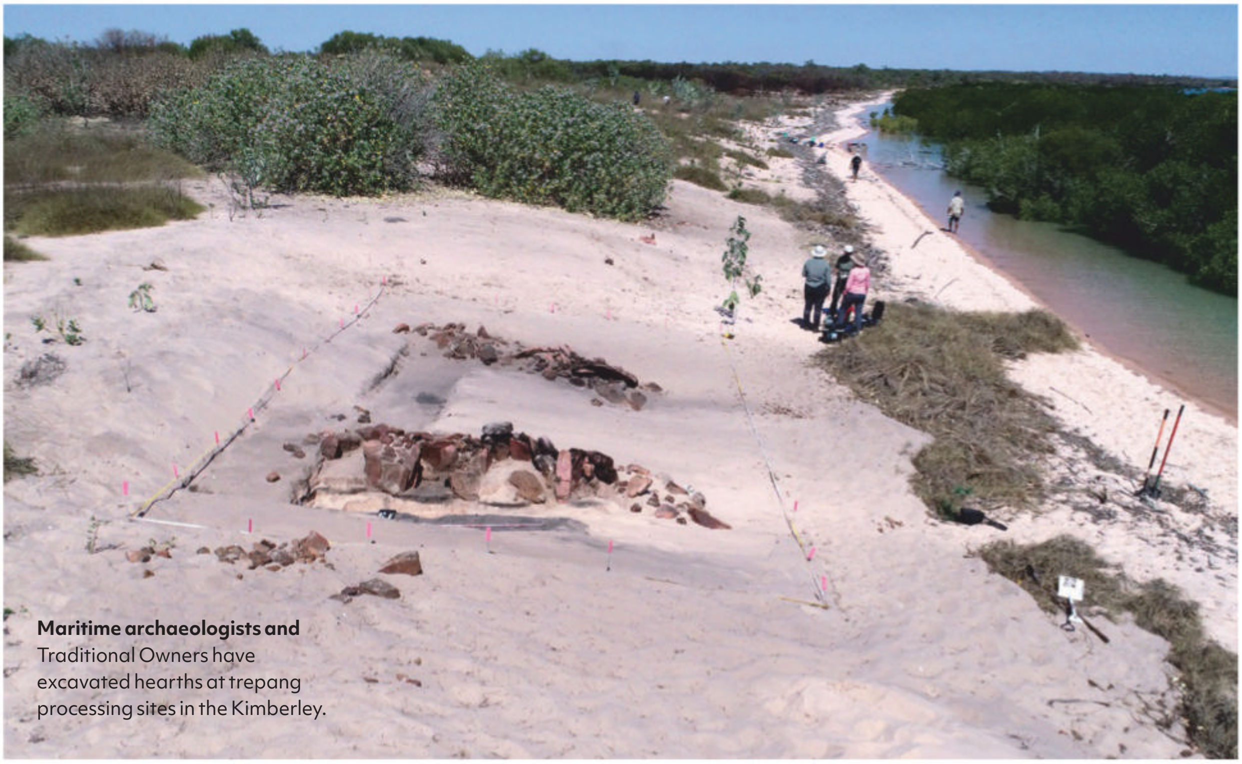
"The sites are signified by these lines of stones, which are actually individual cooking hearths. You could get four, five or six of them where they would put big pots on to boil down the trepang. They'd then dry it and smoke it and prepare it for transshipment back to Indonesia, where it would then go off to Chinese markets."

Inside the WA Museum Boola Bardip, Corioli points out artefacts from one of these archaeological sites. "Bernadette Waina, who's one of the Elders we work with there, she actually found this little spout of a teapot," Corioli says. The display also showcases a musket ball, a fishing hook, the top of a cooking pot and pieces of ceramic pots that are confirmed to be of Southeast Asian origin.

The timeline of the trepang trade is difficult to nail down definitively. According to Lynette, archaeological studies in the NT indicate people could have been visiting northern Australia, probably in 'drift' voyages, between the years of about 1000 to 1550.

"Then from 1550 to 1750 we have what we call 'voyaging entrepreneurs' – people from islands of Southeast Asia semi- ►

Tidal Moon divers sail into Shark Bay to harvest wild sea cucumbers and help restore local seagrass meadows.

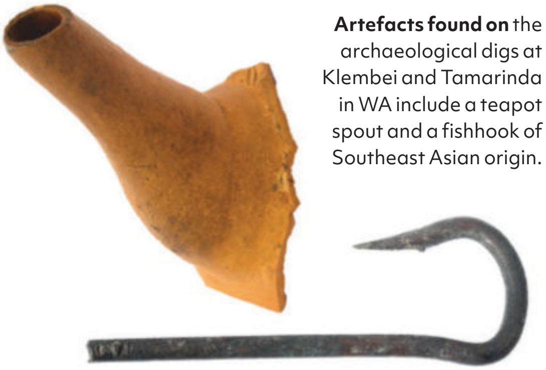


Maritime archaeologists and Traditional Owners have excavated hearths at trepang processing sites in the Kimberley.

regularly meeting with Australian people seeking resources [and] maritime commerce including, of course, trepang," she says.

"The proper trepang industry really takes off around the mid part of the 18th century, and that's really well-documented in written archival records, particularly those based in the port of Makassar."

In the Kimberley, Corioli's team used radiocarbon and accelerator mass spectrometry to date organic materials such as charcoal and marine shells from hearths at trepang processing sites. This dating suggests the Makassans were visiting potentially from as early as 1600. Aboriginal rock art depicts Makassan praus, and this is another mechanism for dating, although it's not definitive.



Artefacts found on the archaeological digs at Klembei and Tamarinda in WA include a teapot spout and a fishhook of Southeast Asian origin.

REGARDLESS OF WHEN the trepang industry began, it's clear the Makassans left a legacy. They introduced First Nations peoples to tobacco, smoking pipes, calico, fishhooks and, in Arnhem Land, dugout canoes. This cultural mashup also led to an exchange of language. Hundreds of words borrowed from Malay, Bugis and Makassarese are still used in northern First Nations communities.

Before Christianity arrived in this part of Australia, the Muslim Makassans had already shared some religious ideas. Prayer-men (or imams) accompanied their fleets. Lynette says representations of Islam are found in First Nations artworks. "Often you get a star or an anchor," she says. "Both of these things are traceable to Islam."

In the NT, at least, it seems the residents and the visitors mostly coexisted in harmony. "These are people who were very, very connected to their country," Lynette says of the Traditional Owners. "But the Makassans didn't arrive intending to take the land off them. What's clear to me is what emerges out of this trade is friendship."

The ultimate expression of this friendship was that many First Nations passengers were known to sail back to Sulawesi with the Makassans. They were mostly young men, apparently seeking adventure. Some of these travellers stayed and had families in Makassar, and stories exist of others who returned, perhaps leaving a Makassar-born family behind. Conversely, some Makassan traders had First Nations wives and children.

From 1883, the South Australian government that administered the present-day NT started charging Makassans for a fishing licence, which likely diminished the viability of the industry. After Federation in 1901 and the introduction of the White Australia policy, the Australian Government saw little advantage in trading with our Asian neighbours, focusing on other exports to Britain.

The last Makassan prau sailed to northern Australia in 1907, after which the SA government refused to renew fishing licences for non-Australian operators. In some cases, friends and families became divided.

However, given the long tradition of Indonesian fishing in Australian waters, traditional fishing rights in some Australian waters still exist today under an intergovernmental memorandum of understanding (MOU). Some 200 nautical miles north of Broome in an area including Seringapatam, Scott and Ashmore Reef, the 'MOU Box' is a designated area where (excluding sanctuary zones) artisanal fishers may catch certain species, including sea cucumbers. Fishers may only fish from

PHOTO CREDITS: COURTESY WESTERN AUSTRALIAN MUSEUM

Michael plans to breed sea cucumbers in a land-based facility, removing the need for ocean harvesting.

Trained divers from Tidal Moon are pulled slowly through the water by a boat, collecting sea cucumbers in a catch bag.

non-motorised boats, and by traditional means. The Australian Border Force patrols these waters, and fishers in breach of these conditions risk jail or seeing their vessels confiscated or burned.

IN A FULL-CIRCLE moment, First Nations peoples, albeit further south, are reviving the ancient trepang industry. Established by Malgana Traditional Owners in Shark Bay in WA, Tidal Moon is a wild sea cucumber harvesting business that combines Western science with traditional land and sea management techniques. In 2017 it was granted an Aboriginal fishing licence to harvest sea cucumbers. The company harvests six sea cucumber species in Shark Bay, including the deepwater redfish (*Actinopyga echinites*), black teatfish (*Holothuria whitmaei*) and the surf redfish (*Actinopyga mauritiana*). Divers hand-pick the sea cucumbers, which are later dried and sold from Tidal Moon's Denham factory.

So far, 14 people have received dive training. "Once you train people up, they have those skills. That human capital cannot be confiscated; they take those skills on to other places, and they have an economic output," says Malgana man Michael Wear, Tidal Moon's managing director. "The best feeling you get is to see the emergence of a middle class, to see people move out of poverty. It makes a big difference to health, family, children [and] just overall wellbeing."

Tidal Moon is exploring Western medicine applications for sea cucumbers through partnerships with several universities and medical research institutions. The company's factory is being upgraded to export standards. As the company scales up, Michael plans to breed sea cucumbers in a land-based facility, removing the need for ocean harvesting.

Extensive seagrass beds grow in the same ecosystem as sea cucumbers, so Michael also sees further opportunities for First Nations peoples in seagrass restoration. Seagrasses store up to 10 times as much carbon as rainforests, so Tidal Moon and its trained divers are poised to participate in the emerging 'blue carbon' economy.

In September 2024 Tidal Moon received a groundbreaking 13-year permit for seagrass translocation in the Shark Bay World Heritage Area, and in 2023, the company received a $2.2 million BHP Blue Carbon Breakthrough Grant.

"The work that we do, we do for many reasons, but one of them is for our Elders," Michael says. "We know what they went through, and we want to make sure, before they go on, that they see Country has been looked after, and the next generation is keeping culture alive."

It seems fitting that the humble sea cucumber, Australia's oldest export, is set to be part of that positive future. ■

PHOTO CREDIT: COURTESY TIDAL MOON/GIACOMO D'ORLANDO

Rain Plaado inspects his SnailCam unit installed on a tractor at Pinehills Pastoral, around 61km from Esperance in WA.

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REGIONAL INNOVATIONS

In this three-part series, AUSTRALIAN GEOGRAPHIC explores how innovative minds in Australia's regions are proving that remote areas are hotbeds of ingenuity – and are helping to shape our nation's economic future.

ON THE SNAIL TRAIL

STORY BY **MANDY MCKEESICK**
PHOTOGRAPHY BY **DUNCAN WRIGHT**

In Western Australia's Esperance region, an Estonian migrant is solving an age-old pest problem in farming.

AUSTRALIA'S INNOVATION LANDSCAPE is often viewed through the lens of its major cities, but look closer and you'll see innovation is thriving in our regional areas. These are places where necessity breeds invention, and where challenges are met with resourceful solutions.

For centuries in Australia, our geographical remoteness has shaped our history and identity. This was outlined famously in Geoffrey Blainey's seminal book, *The Tyranny of Distance*. And in our regions, that notion is amplified. One need only think of the number of problems solved over the years with a length of Number 8 wire or a strand of hay baling twine to appreciate the inherent resourcefulness of those living and working outside major cities. Harnessed the right way, regional innovation – driven by resourceful locals, skilled migrants and a knack for problem-solving – has the potential to add billions to the national GDP.

Central to understanding this is recognising that innovation doesn't have to be confined to labs and research institutions. Just as often, it's a practical endeavour deeply rooted in the needs of local communities. Indeed, Julia Spicer, who spent 18 months as the Queensland Government's chief entrepreneur during 2023 and 2024, is never surprised when she hears stories of ingenuity out of regional areas. "Innovation is finding new ways of solving existing problems and I think, regionally, we do that really well," she says. "We are, by default, efficient problem-solvers."

During her chief entrepreneur tenure, Julia found innovation followed national trends but was often state-centric. Western Australia, for example, is known for its mining expertise. South Australia is known for defence. Julia positioned Queensland as the state for agricultural development and food security. She believes a greater understanding between the city and the regions would serve all parties better. "There were often times I was sitting around pretty important tables with pretty powerful people, and I'd ask a question, and everybody thought my insights about the regions were unbelievably amazing. Then I'd say to them, 'I'm not the only one. There is intelligent life beyond the range.'"

> **"Innovation is finding new ways of solving existing problems and I think, regionally, we do that really well."**

WELL BEYOND THE Great Dividing Range, in the south-west corner of WA, Estonian migrant Rain Plaado was looking for a solution to an agricultural problem. In between trips as a backpacker, the 38-year-old was working for Kirk and Lisa Jeitz at Pinehills Pastoral, a broadacre cropping property growing wheat and canola in the Esperance region, when he learned of an ongoing issue involving snails.

"We get tiny, 1-5mm conical snails in crops, which end up in the grain during harvest. They are hard to clean out, and you can't deliver grain with snails in it," Rain says. It's a dilemma common in the Esperance area, and one that can significantly impact crop yields and profitability for farmers in the region. "We don't have them everywhere, so I thought it would be handy to know where they were exactly – because when you have 6500ha to drive around, it's pretty hard to see them."

It was this practical need that sparked Rain's innovative journey. He first came to Australia as a backpacker in 2014, and in 2019 he migrated permanently with his family and continued to work at Pinehills as a farm hand. But Rain also has a degree in technotronics from the Estonian University of Life Sciences – not to mention a restless, enquiring mind. And so, he brought those skills to Pinehills.

"As an engineer who loves building and improving things, I started looking into machine learning and camera-based object detection," he says. With no prior experience in this field, Rain developed SnailCam, a camera system that can attach to moving farm machinery, such as a tractor, and map snail populations. Knowing where snails are congregating allows farmers to customise baiting programs, saving money and time and reducing environmental impact.

SnailCam is a simple concept delivering measurable results and has the potential to be applicable to crops worldwide. Rain trialled the model at Pinehills and in 2024 extended it to five more farms in the Esperance area. It's a testament to how a localised problem, combined with ingenuity and technical skills, can lead to a solution with far-reaching implications.

AUSTRALIA, WITH ALMOST three out of 10 residents (29 per cent) born abroad as of 2021, has the third-highest migrant share among OECD countries. Indeed, attracting skilled migrants like Rain is proving to be a key component of regional innovation.

Cate Gilpin works with Welcoming Australia, an organisation dedicated to ensuring people of all backgrounds have an equal opportunity to belong, contribute and thrive. "Migrants can re-liven communities with new ways of thinking and doing," she says. "Diversity brings innovation in thinking. It brings global knowledge. It brings competencies in other areas. We're moving to a global world, and you need people who can speak diverse languages and who have lived in circumstances different to our own."

The story of Rain Plaado and SnailCam illustrates this point perfectly. His migration to regional WA brought a unique skillset and perspective that directly addressed a local agricultural challenge. What's more, attracting people like Rain and his family to regional areas brings multiple benefits. His wife manages two Esperance holiday properties, and his children bolster numbers at the small Cascade Primary School, where the youngest is the only one in his class.

A study by the Organisation for Economic Co-operation and Development (OECD) confirms these anecdotal observations, finding that migration has a tangible impact on regional innovation. According to the OECD Regional Development paper *Migration and regional innovation in Australia*: "A one percentage point increase in the regional employment share of higher-educated migrants relative to total employment leads to a 4.8 per cent rise in regional patent applications in the medium run (five years)." This is a major boost, and shows that attracting skilled individuals to regional areas can directly translate into increased innovation and economic growth. ►

SNAILCAM
snailcam.com.au
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Rain uses a tablet to check the focus on SnailCam, a camera he designed, programmed and manufactured.

Rain, a former Volvo mechanic and trained engineer in Estonia, works on his CNC machine to cut new parts for his camera.

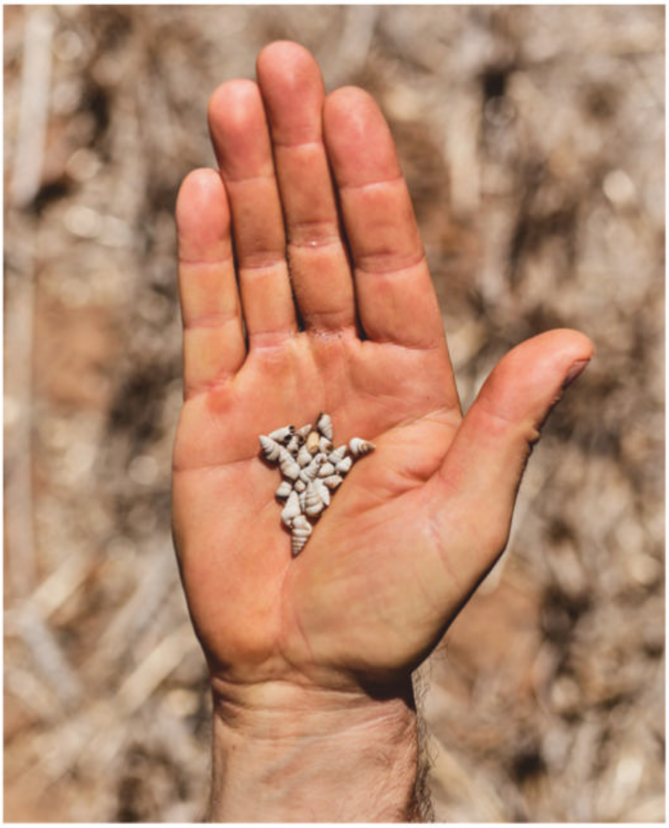
SNAILCAM IS STILL in the early stages of development. "I've used 100 per cent of my own money and developed this in my spare time," Rain says. "But I've had support from Kirk and Lisa, our neighbours and the local agronomists who all have faith in this technology." As SnailCam is refined and upscaled, Rain may be able to access grants and avail himself of the knowledge in government-backed innovation hubs.

Innovation hubs exist in each state, designed to bring together innovators, researchers, industry bodies and those with funds to invest. They're places where ideas can be shared and experience gained, and all have a regional component supporting an array of different industries. These hubs play a vital role in nurturing regional innovation by providing access to resources, expertise and networks that might otherwise be unavailable.

For example, in South Australia, Innovation Places has created a manufacturing precinct in the Upper Spencer Gulf for green hydrogen and renewables. In the Northern Territory, Innovation Territory promotes anything from healthcare projects in Alice Springs to tourism in Katherine. In Western Australia, innovation hubs are helping researchers develop X-ray fluorescence machines to detect microscopic gold in the field.

Beyond SnailCam, the agricultural sector across Australia is seeing a surge of innovation. These advances are aiding productivity and transforming traditional practices, opening up new opportunities for farmers and communities. From novel beekeeping methods to cutting-edge agricultural technologies and the exploration of alternative crops, Australia's regions are at the forefront of this agricultural revolution.

Flow Hive [AG 181], developed by father-and-son beekeper duo Stuart and Cedar Anderson near Byron Bay, NSW, has



A palmful of conical snails: these snails are roughly the same size as the seeds that are harvested on the farm at Pinehills Pastoral, causing issues when it comes to processing.

revolutionised beekeeping with its innovative honey extraction system that allows beekeepers to harvest honey without disturbing the bees. The ingenious design features pre-formed honeycomb cells that the bees naturally fill with honey. Once the cells are capped, beekeepers use a special tool to split the cells, allowing the honey to flow into a collection trough without opening the hive or handling the frames. It reduces stress on the bees and simplifies the honey harvesting process, making it easier for both experienced and novice beekeepers to enjoy the fruits (or rather, honey) of their labour.

TerraLab, on the Bass Coast of Victoria, is also pushing the boundaries of agricultural technology, and has won a swag of awards in the process. It focuses on precision farming and sustainable land management practices, bringing together researchers, farmers and technology developers. TerraLab's projects range from developing advanced sensors for monitoring soil conditions and crop health to creating data-driven decision support systems that help farmers optimise their resource use.

And in Cressy, Tasmania, Andi Lucas founded X-Hemp, bringing innovation to an industry that until recently has been unable to fully develop its potential. On the back of decreased regulation, turning hemp waste – the stalks and trash left over from harvest – into an industrial product is now an emerging industry, and X-Hemp is leading the charge. Materials made from hemp are non-toxic, can sequester carbon, and importantly for Australia's bush, are fire-resistant. The possibilities are exciting.

We'll look closer at Andi and X-Hemp later in this three-part series on Regional Innovations. Of course, regional innovations go beyond agriculture, too. Later in this series we'll meet Mia Ryan, who created a dating app named Howdy for rural Australians. There's Dennis Fay, a firefighter from Cairns who now owns Salty Monkeys, an adventure apparel and dive gear brand that's helping conservation in the Torres Strait. And in another boon for conservation, we'll meet researchers from the Burnett Mary Regional Group who have developed a sprinkler system that emulates rainfall to save critically endangered freshwater turtles.

WHILE HARD DOLLAR contributions to regional economies may be difficult to quantify, innovative businesses also grow beyond their immediate communities. "There is what's called a spillover effect where surrounding businesses benefit," says Dr Chad Renando from the Rural Economies Centre of Excellence at the University of Southern Queensland. "In research we did with the Gold Coast hub, we found that while there may be a decrease in local employment as a business scales and engages employees offshore, the overall staffing of the network increases for full-time, part-time, contract, and volunteer staff."

Regional innovation also has a tendency to even out the peaks and troughs of the national economy. A report by the Regional Australia Institute (RAI) found that during the global financial crisis in 2009, when city-based growth was slowing, regional Australia took up the slack and contributed 50 per cent of national economic growth. Even when times had improved by 2022, the regions accounted for 34 per cent of GDP. In addition, the RAI estimates attracting more skills to the regions, for example with skilled migrants such as Rain, could add $25 billion per year to the economy.

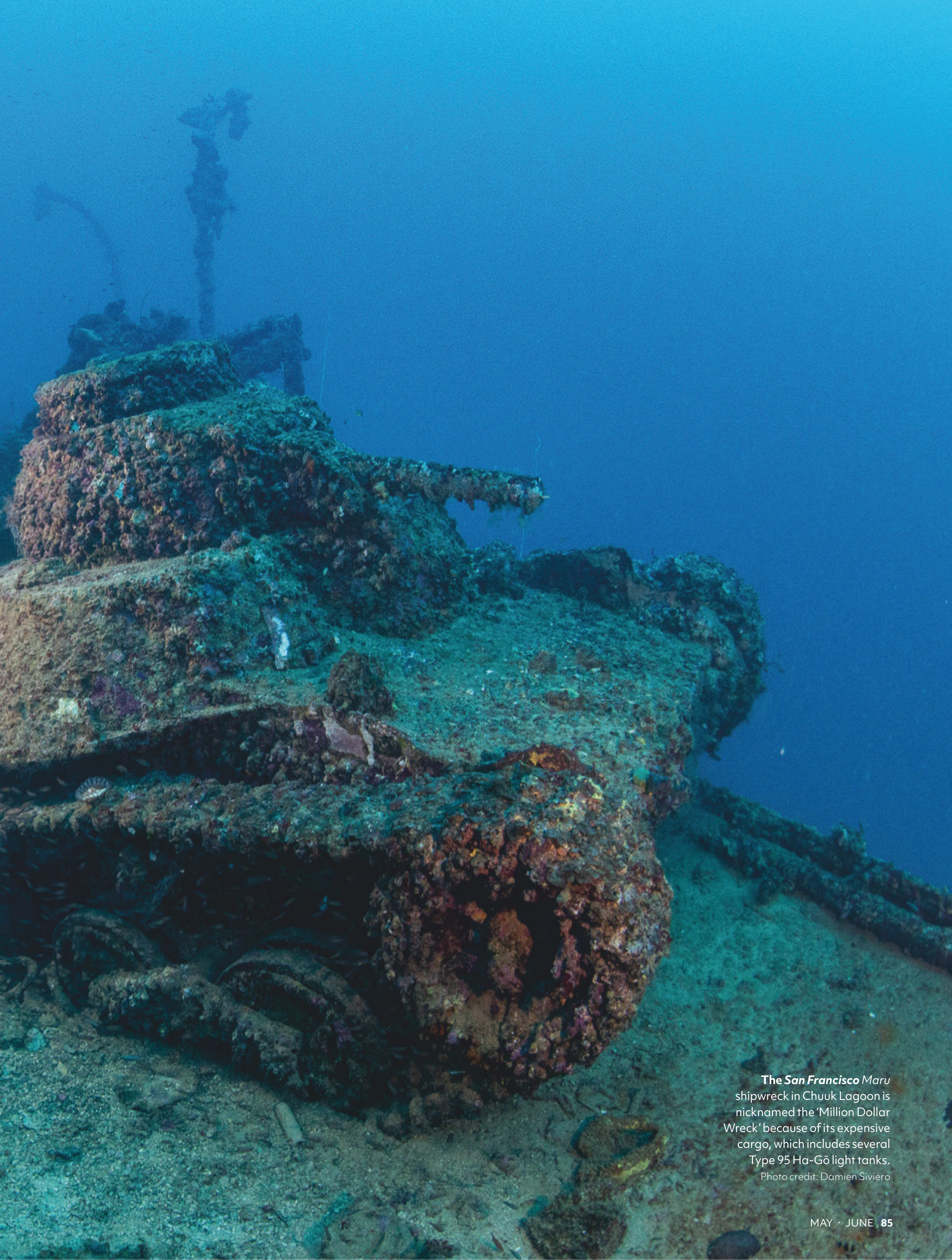
Back in Esperance, Rain Plaado continues to refine SnailCam, driven by his passion for problem-solving and a commitment to his newfound community. He's a prime example of the ingenuity and resilience that defines regional innovation in Australia. His story, along with countless others across the country, demonstrates the immense potential that lies beyond the major cities. And with further investment and support around the country, we can ensure that innovation doesn't move at a snail's pace. ■

Rain welds parts, cut on his CNC machine, that willl form the main body and housing for SnailCam.

CLEANING UP TOXIC WAR RELICS

STORY BY **ESME MATHIS**

Australian maritime archaeologists are helping to decontaminate rusty war shipwrecks in the Pacific, preventing billions of litres of oil and other pollutants from leaking into the ocean.



The *San Francisco* *Maru* shipwreck in Chuuk Lagoon is nicknamed the 'Million Dollar Wreck' because of its expensive cargo, which includes several Type 95 Ha-Gō light tanks.
Photo credit: Damien Siviero

ON 7 MAY 1942 a World War II naval battle was unfolding in the heart of the Coral Sea a few hundred kilometres off the North Queensland coast. At 0720 hours Japanese scouts spotted the American oil tanker USS *Neosho* and its destroyer escort USS *Sims* en route to refuel US navy ships. Mistaking the tanker for an aircraft carrier, the Japanese command dispatched torpedo bombers against the American vessels. By morning's end, both ships and many of their crew had been claimed by the sea.

It's not known how much oil the *Neosho* contained when it was torpedoed during the Battle of the Coral Sea – or how much remains stored inside this shipwreck 83 years later. All of *Neosho's* oil may have spilled into the ocean when it was bombed in the 1940s. But there's a chance the shipwreck still holds significant quantities inside fuel tanks that are slowly but surely corroding in the ocean's salty waters.

The *Neosho* is one of thousands of WWII shipwrecks scattered across earth's oceans. These mostly steel or iron hulks have sat in a salty, corrosive environment for more than 80 years and are now deteriorating: some leaking globules of oil into the marine ecosystems; others on the verge of collapse, threatening to release multiple tanks' worth of bunker fuel. The condition of each WWII shipwreck and the pollution risks they pose vary – but collectively, they're known as 'potentially polluting wrecks' (PPWs).

An IUCN report published in April 2023 identified more than 8500 PPWs across the globe, mostly from WWII, and estimated that these hold 6 billion gallons of heavy fuel oil (22.7 billion litres) – more than 30 times the amount released in the 2010 Deepwater Horizon disaster, the largest marine oil spill in history. As well as oil, some PPWs have unexploded munitions and chemical weapons that contain heavy metals. The long-term effects these pollutants could have on ocean chemistry and marine life is not yet fully understood.

"It will get to a point where whatever oil was left in them, it will be released," says Dr Matt Carter, maritime archaeologist and research director for the Major Projects Foundation, a not-for-profit based in Newcastle in New South Wales that's working to decontaminate high-risk PPWs throughout the Pacific. "The big concern is that these wrecks have been underwater for so long that they'll get to the point where they collapse, they simply don't have the [structural] strength anymore… But the multimillion-dollar question is, how much oil is there?"

Aside from corrosion, there are several things that might affect a WWII shipwreck's structural integrity, such as its depth and orientation on the seabed. "It's a case-by-case basis, so it really depends on how the ship was sunk," Matt explains. "Did it sink slowly and intact, or did it get blown into pieces? Is it upright, or is it lying on its side?" The latter is more prone to collapse compared to an upright wreck, because its structural supports weren't designed to bear the weight on its sides. Matt says these rusting supports can suddenly give way, causing the ship to flatten like a pancake and release its oil all at once.

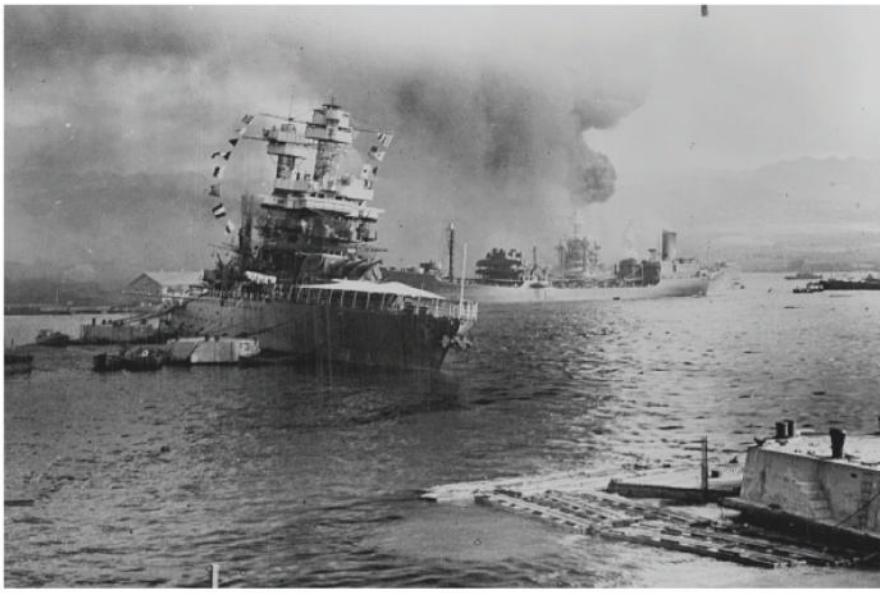
Shipwrecks in shallow waters are usually less stable than deep-water wrecks, because they are more likely to be disturbed by boats and divers, impacted by storms, and knocked about by waves and currents. "The conventional thinking is that the deeper the shipwrecks are, the more stable they are," Matt says. "But even so, we know these wrecks are corroding over time, and we do have evidence from overseas that even deep wrecks release oil. We have some slicks coming up from wrecks in the Solomon Islands that are over 1000m deep."

THE GOOD NEWS is that decontaminating a PPW is a reasonably straightforward task. It typically involves a group of scuba divers descending to the shipwreck site, drilling holes into its tanks and pumping out the oil, then returning to the surface to dispose of it. "It's pretty surgical," Matt says. "You keep the wrecks as intact as possible." This type of prevention is also a fraction of the cost of cleaning up an oil spill after a shipwreck collapse, which the Major Projects Foundation estimates to be 10 to 20 times more expensive.

Decontaminating shipwreck sites is being done routinely in places such as the US and in the Baltic. Australia hasn't yet carried out these preventive measures – but has the right experts, tools and technology to respond to an oil leak quickly and efficiently should the need arise. "Australia has quite good oil spill response capability," Matt says. "We know these wrecks are on our doorstep here in Australia, but we do have some response capability, which makes them a lower risk overall."

The same can't be said for Australia's neighbours in the Pacific. "When we go to the Solomon Islands or Micronesia, they just don't have any [oil response] capability," Matt says. "[They're in] a vulnerable position in terms of oil spills – that's where we focus our attention."

> "The big concern is that these wrecks have been underwater for so long that they'll get to the point where they collapse."



Chuuk Lagoon was a Japanese naval base that was bombarded in 1944 during Operation Hailstone. The lagoon is now a time capsule of WWII artefacts (right).

Amid Japanese fire, the fleet oiler *USS Neosho* (opposite, pictured in background) escapes from Pearl Harbor on 7 December 1941. She was torpedoed during the Battle of the Coral Sea five months later as hostilities continued.

PHOTO CREDIT: GETTY IMAGES (LEFT); ALAMY (ABOVE RIGHT)

The Major Projects Foundation has partnered with the Secretariat of the Pacific Regional Environment Programme to help build the oil-response capability of Pacific Island communities across Samoa, the Federated States of Micronesia, Fiji, the Republic of the Marshall Islands, Solomon Islands and Vanuatu. "We work collaboratively with the people in these countries, [where] the problem is in their backyard," Matt says. "They didn't cause the problem, but they're the ones having to face the impacts now."

Of the 8500 PPWs identified in the IUCN report, an estimated 3800 lie in the Pacific. Of these, Matt and his team have identified 60 high-priority wrecks that need urgent attention, about a third of which lie inside Chuuk Lagoon (formerly Truk) in the Federated States of Micronesia.

"In Chuuk, you get these wrecks that have become artificial reefs and just absolutely covered in fish life, and they're still full of thousands of litres of oil," Matt says. "The wrecks in Chuuk are amazing historic archaeological sites, and yet they are this pollution threat. They're also tourism assets and war graves, so we're very careful around how we deal with the shipwrecks. It might be easier to remove the entire wrecks, but that's not something we'd look to do because they are cultural sites and the rest of it."

The Major Projects Foundation received funding from the Australian Government through its foreign-aid budget to visit the Chuuk Lagoon and help local authorities deal with the issue. The project is also building local capacity for the Chuukese to assess and remediate high-risk sites in the future. "Chuuk Lagoon has been our big project over the last few years," Matt says. "We went diving on the wrecks and mapped them, surveyed them, to understand what condition they're in and get a better idea of how much fuel could still be on them." This data also allowed Matt and his team to do oil-spill modelling, which identified where the oil would travel if a large amount was suddenly released. ►

SIX OF THE 60 high-priority shipwrecks identified by the Major Projects Foundation lie in Australian waters. Three are American naval ships – the *Neosho*, the *Sims* and the USS *Lexington* – inside Queensland's Coral Sea Marine Park. Two lie in Victoria's southern waters: the US merchant ship MV *City of Rayville*, inside Apollo Marine Park near Cape Otway; and the SS *Cambridge*, a British merchant vessel inside Beagle Marine Park in the Bass Strait. Both sank after striking German mines in November 1940.

The sixth is the MV *Limerick*, a New Zealand–registered British cargo vessel that lies about 18km off the coast of Ballina and Cape Byron in northern NSW. On 26 April 1943 the 8724-tonne steamship was travelling in a convoy from Sydney to Brisbane when a Japanese torpedo struck its port side. Seventy of its 72 crew survived.

Multibeam imaging of the shipwreck by CSIRO in 2012 revealed the 140m-long shipwreck rests upside down on the seabed. That's a good thing in terms of its structural stability, but slightly disappointing for maritime archaeologists looking to study the wreck. "It's completely inverted, which is a real shame because all the interesting stuff is on the top," says Dr Brad Duncan, senior maritime archaeologist with Heritage NSW. Heritage NSW, part of the Department of Climate Change, Energy, the Environment and Water, is the government body tasked with identifying, managing and protecting NSW shipwreck sites on behalf of the Commonwealth Government.

Dr Matt Carter, research director of the Major Projects Foundation, is working to mitigate the pollution threats of legacy shipwrecks across the Pacific.

A pocket of oil (below) accumulates inside a Japanese shipwreck in Chuuk Lagoon.

The *Limerick* is the only WWII shipwreck in NSW that's known to leak oil. "It's not a common problem that we've got up and down the coast," Brad says. "The *Limerick* is the only one in the state where we've ever had that issue."

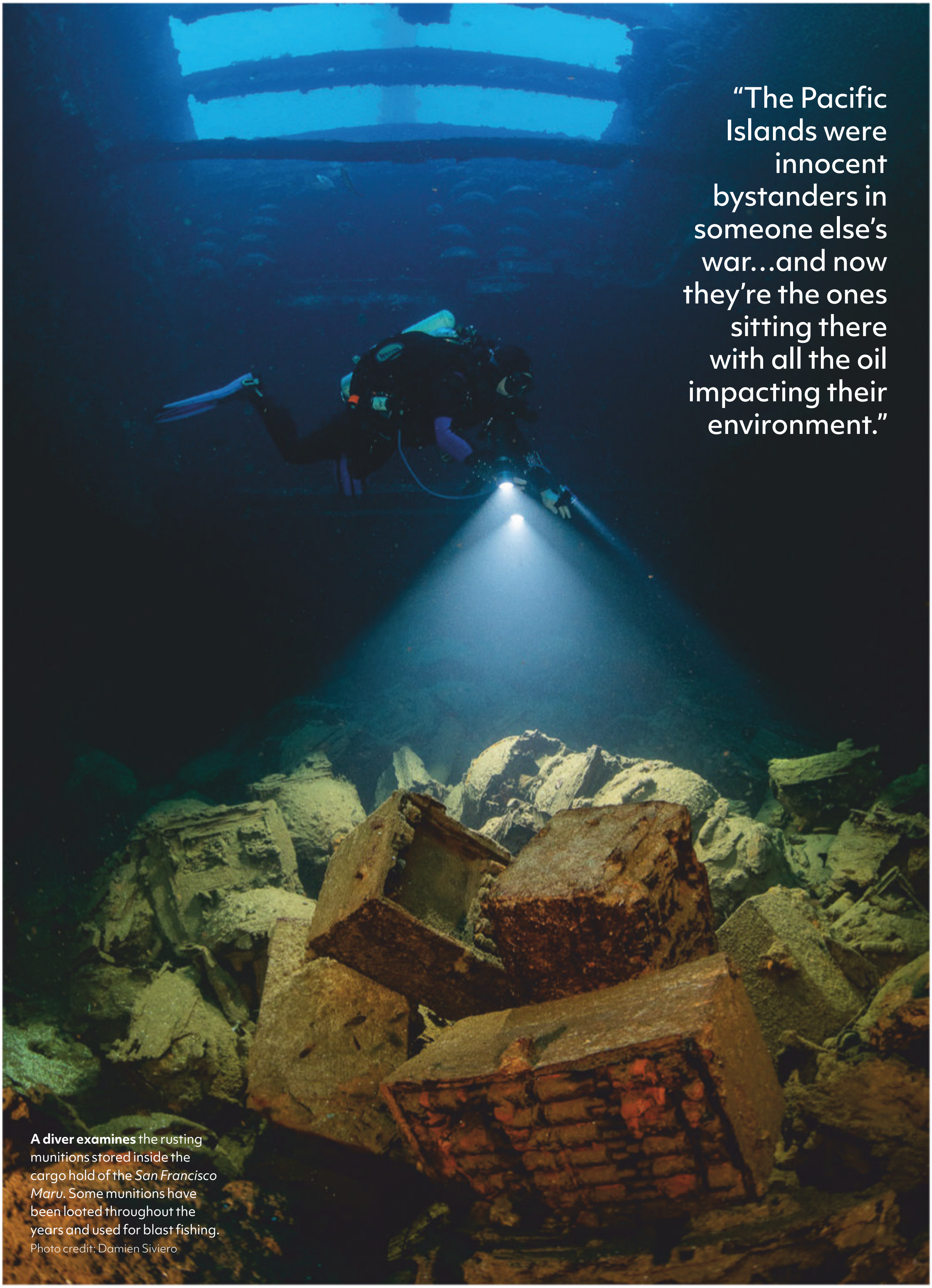
Despite this oil leak, the *Limerick*'s structural stability, depth (about 90–100m) and offshore location means it doesn't pose much of an environmental risk compared to other wrecks in the Pacific. Naval warships carried significant quantities of fuel that allowed them to cross vast expanses of ocean. The *Limerick*, on the other hand, was a merchant vessel sailing from Sydney to Brisbane; it probably held enough fuel to only cover that stretch of the coastline. Brad says most of this fuel would've been released in the immediate aftermath of the torpedo strike. "The size of the charge that exploded the vessel is more than likely to have ruptured most of the oil tanks at the time," he says.

Tim Smith OAM, maritime archaeologist and director of assessments at Heritage NSW, agrees that the environmental risk posed by the *Limerick* isn't cause for major concern. "It's a moderate risk in NSW waters," he says. "I think it's hard to say if one of our wrecks [will] fall apart in the next 50 years and create a polluting event. Because of where they are in Australia – in the coastal waters – it's less of a marine environmental risk, because they're usually offshore, outside of coastal zones. But it's an aspect of the management of wartime ships that Heritage NSW is acutely aware of and is monitoring."

When the *Limerick's* oil leak was first discovered, Heritage NSW monitored the site over a period of about three months. "We collected samples of the oil on the surface and sent it to laboratories and had it analysed," Tim says.

The lab report revealed the oil was bunker fuel and lubricating oil. "That indicated that one of the fuel tanks on the wreck had failed because of corrosion, and that [oil] had been seeping out. Often it's not a catastrophic thing; it's small globules of fuel oil going up to the surface, and it expands on the surface and dissipates," Tim says. "These big ships had up to 10 major fuel tanks on board, so this is probably a minor one that had failed, because it did effectively bleed out and the risk dissipated. But it's something we manage as a managing authority, because it's a bigger story in the Pacific." ▶

PHOTO CREDITS, TOP TO BOTTOM: COURTESY MAJOR PROJECTS FOUNDATION; PETE MESLEY



"The Pacific Islands were innocent bystanders in someone else's war…and now they're the ones sitting there with all the oil impacting their environment."

A diver examines the rusting munitions stored inside the cargo hold of the *San Francisco Maru*. Some munitions have been looted throughout the years and used for blast fishing.
Photo credit: Damien Siviero

IN THE FEDERATED States of Micronesia, the issue of polluting WWII shipwrecks is not a hypothetical worry but a reality. In WWII, Chuuk Lagoon was a vital Japanese naval base that housed more than 37,000 Japanese people. Today, more than 50 Japanese shipwrecks lie submerged in its waters, along with dozens of aircraft, submarines and tanks. The sheer number of shipwrecks in Chuuk has made it one of the world's best-known scuba-diving sites, attracting thousands of tourists each year. But the economic future of this region is beginning to look uncertain as oil released from rusting shipwrecks washes up on beaches and pollutes local fish stocks.

Dr Bill Jeffery is an Australian maritime archaeologist at the University of Guam who has spent decades working in Chuuk Lagoon. Over the course of his career, he has witnessed the deteriorating condition of the lagoon's shipwrecks. "They're starting to collapse and deteriorate significantly now," he says. "Over the years, they've been leaking oil gradually. As these sites start to collapse more and more, oil will potentially come out in volumes."

Bill explains that 'cathodic protection' can slow down corrosion on shipwrecks. Cathodic protection involves one of two methods: either applying a controlled electrical current to prevent corrosion; or using 'sacrificial anodes' such as zinc or aluminium, which can act like a shield that corrodes instead of the ship's iron. But applying cathodic protection to all the submerged shipwrecks in Chuuk is not financially feasible. "These are big ships – 10,000-tonne. Not as big as present-day ships, but in Chuuk there are 50 of them," Bill says. "It's a big, big, big task, and it just won't happen. Maybe we'll save one or two of them. But, you know, you're looking at hundreds of millions of dollars."

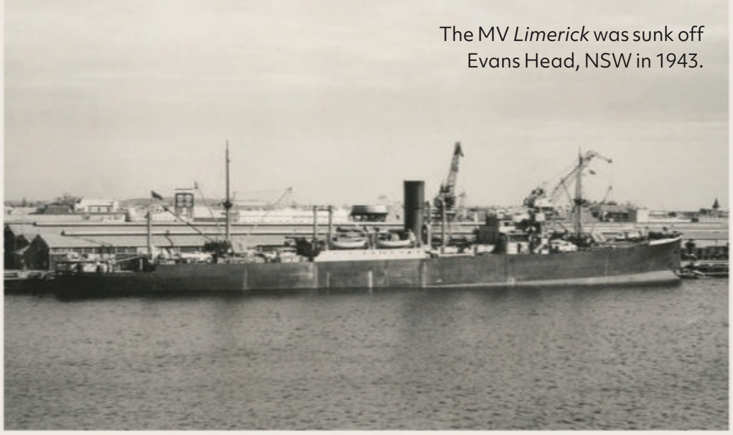
The question of who is responsible for cleaning up these oil spills – and who should foot the bill – is a contentious one. The US has removed oil from some of their PPWs across the Pacific. Japan has too, but not at scale. "The Japanese have been doing stuff over the last 10 years, but it's very piecemeal, very labour-intensive," Bill says.

The rest is ultimately left to the Pacific communities. "They [were] innocent bystanders in someone else's war…and now they're the ones sitting there with all the oil impacting their environment," Bill says. "It's not their responsibility at all."

These rusting warships have sovereign immunity, which means they remain the property of the state that owned them at the time of sinking. Legally speaking, the Japanese wrecks in Chuuk Lagoon belong to Japan, not the Federated States of Micronesia, so they cannot be removed from the water or salvaged for parts. Their status as maritime graves makes the issue more politically sensitive. "The countries [US and Japan] say it's their shipwrecks,

Torpedoes, depth charges and other munitions litter the cargo holds of the *San Francisco Maru*.
Photo credit: Damien Siviero

COMBAT OPERATIONS OFF THE NSW COAST



The MV *Limerick* was sunk off Evans Head, NSW in 1943.

The MV *Limerick* was the largest merchant vessel sunk by enemy submarines off the NSW coast during World War II. Merchant vessels – transporting vital supplies for both the home front and the war effort abroad – were routinely targeted because they often travelled out of convoy and had poor defences. Nineteen vessels were sunk between 1940 and 1944, claiming the lives of 214 merchant seamen and military personnel. At least 10 more ships were torpedoed but didn't sink.

Tim Smith OAM, maritime archaeologist and director of assessments at Heritage NSW, says it's a lesser-known chapter in Australia's WWII story. "People don't understand the scale of the military operations against our shipping," he says. "It was really a major story of the war that was so secret at the time because the Australian Government and the Allies didn't want to alarm the population."

Most of the merchant vessels torpedoed off the NSW coast were local traders, transporting grain, produce or raw materials such as iron ore between Australian cities. In 1943 the *Wollongbar II* was transporting 18,000 boxes of butter, bacon, sugar and bananas when it was torpedoed off Crescent Head on the Mid North Coast.

"Boxes of butter washed up on the beach," says Dr Brad Duncan, senior maritime archaeologist with Heritage NSW. "There were a lot of cakes being produced after that, because [before that] there was no butter around. There's one really great story where local kids found a massive box of butter – three or four feet long, chock-a-block full – and had a butter fight." The children returned home in butter-splattered clothing to furious mothers, who scolded them for wasting the rationed commodity.

Some merchant ships, however, were transporting military equipment and supplies to the warfront. On 22 July 1942 the US Liberty ship *William Dawes* was bound for the Pacific Theatre when it was torpedoed near Tathra in southern NSW by the Japanese submarine *I-11*. Its lost cargo included ammunition, 82 jeeps, 12 ambulances and 72 'pick-up trucks' (utes).

Tim says Japanese submarines carried out these attacks to disrupt the Allies' shipping and supply lines – not to invade Australia. "We've identified 10 Japanese submarines that were tasked to attack ships on our coast during 1942 and '43. That's a huge logistical feat by the Japanese Navy," Tim says.

German vessels were also active in the region, laying minefields in NSW waters in 1940, which caused several shipwrecks. In December 1944 a German U-boat patrolled the region, sinking the US Liberty ship *Robert J Walker* off Jervis Bay on Christmas Day.

> "Most of these wrecks are in areas with high biodiversity. The oil spills...threaten coral reefs, which are important breeding grounds."

their material remains, their cargo," Bill says. "I guess it's ironic because if they found valuable cargo, they'd be jumping up and down about wanting to take it, protect it. But when it's the oil coming out, no one really wants to do anything with it."

That means it's up to Pacific researchers to come up with innovative solutions to the problem.

Dr Awei Bainivalu is a Fijian scientist who recently completed her PhD in environmental bioremediation at the University of Newcastle. Her PhD investigated whether naturally occurring bacteria or microbes could be deployed onto leaking WWII shipwrecks to 'eat' the toxic oil and convert it into less harmful compounds such as carbon dioxide.

Using oil samples collected by the Major Projects Foundation, Awei analysed the toxic compounds – specifically targeting mono-aromatic hydrocarbons and poly-aromatic hydrocarbons – present in the oil, and also investigated if any naturally occurring bacteria were present in the oil. "I worked on growing the hydrocarbon-degrading bacteria in the lab," Awei says. "I isolated and cultivated a group of bacteria that could be reintroduced into the oil. Then, I experimented with modifying this bacterial consortium and monitored how effectively they could degrade the toxic components over time."

Like most scientific research, Awei emphasises that this isn't a one-size-fits-all solution. "As much as we'd want that to happen that way – you get a superbug, throw it in the sea, and it fixes the problem – it's not that simple," she says. "Each shipwreck is unique, with its own oil fingerprint and associated bacteria. The bacteria I work with may or may not work in other wrecks."

Awei's research was a pilot study she hopes will be the starting point for a larger body of research into novel ways of dealing with marine oil pollution in the future. "Most of these wrecks are in areas with high biodiversity," she says. "The oil spills from these wrecks threaten the coral reefs, which are important breeding grounds. We depend on these marine ecosystems. They're our lifeline. It's crucial that we address this issue. We need to be aware, but unfortunately, many are not." ■

PHOTO CREDIT: COURTESY AUSTRALIAN WAR MEMORIAL

PLASTIC MEASURES

STORY BY **FIONA MCMILLAN-WEBSTER**

Aussie researchers are at the vanguard of scientists worldwide solving the global environmental crisis created by plastic pollution.

Plastic pollution litters beaches around the globe.

THE VAST ECOSYSTEM of Brisbane's Moreton Bay contains a multitude of species. There, in the sheltered waters, winding inlets and salt marshes of Quandamooka country, you can find sharks, rays, and hundreds of fish and coral species. Bottlenose and humpback dolphins swim and forage there, as do dugongs and six of the world's seven species of sea turtle. Meanwhile, the expansive estuary with its shoals, seagrass beds and mangrove forests offers a haven for many endangered species, so you'll see roosting grounds of far eastern curlews, as well as swamp orchids and ant-blue butterflies. You may even see a southern right whale stopping by. But that's not all.

If you take a close look along the shores and among the mangroves, says Dr Elvis Okoffo: "You will see a lot of plastic." Elvis is an environmental scientist at the Queensland Alliance for Environmental Health Sciences at The University of Queensland. He became interested in Moreton Bay a few years ago when he was analysing Brisbane's wastewater and finding a lot of plastic in the samples. "I started asking myself questions. So, we know there's plastics in wastewater," he says. "Where do they go? One of the first things that came to mind was the bay."

When he and his colleagues analysed dozens of sediments from all over the bay, they were surprised by what they found. "There were plastics in almost every site that we analysed," Elvis says. Most of it was in the form of microplastics, which are fragments smaller than 5mm in diameter. Based on their data, they estimated about 7000 tonnes of microplastics have accumulated in the bay, which is equivalent to 700 million half-litre plastic bottles.

Moreton Bay is unique in many ways, but not with regard to plastic pollution, which is a global problem. About 20 million tonnes of plastic waste ends up in the environment each year as it continues to infiltrate almost every conceivable ecosystem, from the peaks of the Himalayas to the bottom of the Mariana Trench, which includes the deepest-known point in the ocean. It's estimated that, by 2050, there will be more plastic in the ocean than fish. So, as a torrent of new plastic joins the profusion of existing plastic waste, it's easy to feel as though the problem has become insurmountable.

But this is not the case at all. In fact, an emerging ecosystem of solutions offers genuine cause for hope. To really understand the plastics crisis, and how it can be solved, we need to take a closer look at what plastic actually is.

THE STORY OF plastics begins with polymers, which are large molecules made of repeating patterns of smaller molecules called monomers. Though some polymers are quite complex, many are just long chains of identical or very similar monomers.

Polymers aren't inherently bad. The natural world is full of them, from the DNA in every living cell to the keratin found in skin, hair, nails, feathers, wool and more. Complex carbohydrates are polymers, including starch and fibre. Cellulose, which is made by plants and microbes, is the most abundant polymer in the world. But as all these 'biopolymers' evolved, so too did biological mechanisms that could break them down, enabling the fundamental building blocks to be reused.

The earliest versions of modern plastics, on the other hand, were invented in the 1800s and involved chemically modifying cellulose from plants. Then, in 1907, the first fully synthetic plastic polymer was made from a mixture of phenol and formaldehyde, and the world hasn't been the same since. Today, almost all modern plastics are made with synthetic polymers which, in turn, are made of petrochemicals sourced from fossil fuels.

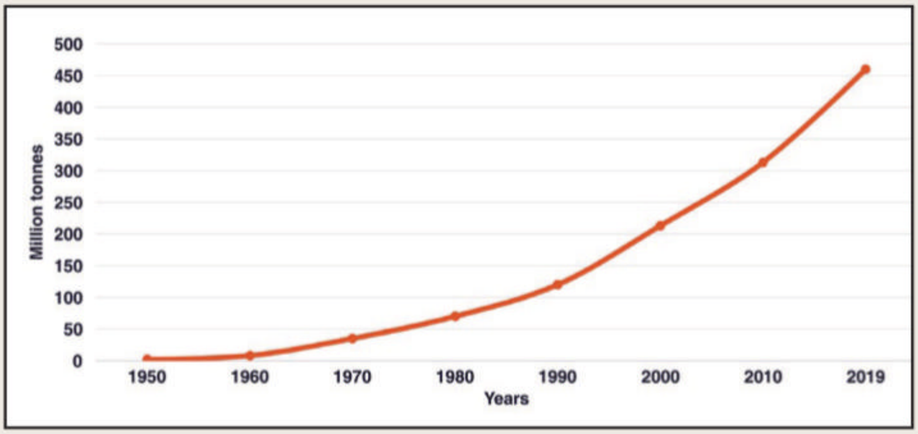
The arrangement of polymers inside plastic is often likened to a bowl of spaghetti and, in keeping with this analogy, ingredients have a big impact on results. The specific monomers used to build a polymer influence its strength and flexibility, as well as how it interacts with other polymers. During production, the addition of chemicals called plasticisers can influence these interactions by encouraging polymers to become more slippery, more tangled, more aligned, more interlinked, and so on. In this way, manufacturers can toggle the flexibility, hardness, durability and density of the final product. This makes plastic an incredibly versatile material with many different uses. It's also relatively fast and economical to manufacture. Consequently, it has reached almost every aspect of modern life.

"We're absolutely surrounded by it," says Emeritus Professor Sarah Dunlop, who leads the Minderoo Foundation's Plastics and Human Health research program in Perth.

But while plastic is undeniably useful, it poses a lot of health risks. "We really tend to think of plastic as safe, cheap and convenient, but I'm going to argue that it's none of those things," she says. Plastics contain "truckloads" of chemicals, she says. In addition to the petrochemical-derived polymers, there are also accelerants and flocking agents, which help build the polymers in the first place. Then you've got all those plasticisers, as well as foaming agents, biocides, flame retardants, UV stabilisers and more.

GLOBAL PLASTICS PRODUCTION

Annual production of polymer resins and fibres



Data source: Geyer et al. (2017); OECD (2022)
OurWorldinData.org/plastic-pollution | CC BY

PHOTO CREDIT, PREVIOUS PAGE: GETTY IMAGES

About two-thirds of new plastic is thrown away within a month of being used.

Dr Elvis Okoffo analyses microplastics in environmental samples.

PHOTO CREDIT: COURTESY THE UNIVERSITY OF QUEENSLAND

"At last count, there are about 16,000 chemicals used to make plastic," Sarah says. Moreover, these chemicals are simply mixed in, rather than being strongly bonded to the polymers. Here, she takes the spaghetti analogy a little further: when additives are mixed in, you get something more like spaghetti bolognese. "The plastic chemicals – the bolognese sauce – they're not stuck to the spaghetti," she says. This means the chemicals can slowly come out of the products. "They leach into food, water and air."

From there, it's a short journey into our bodies where they're capable of harming our health, even at very low levels. Globally, only a fraction of these chemicals are regulated. "It's a form of toxic trespass. We didn't ask for those chemicals to be in us," she says.

It's not the only trespass. "[Plastic products] shed little microplastics and even smaller nanoplastics, and this happens every single day when we're using them," she says. "Both micro- and nanoplastics are increasingly being reported in human tissue. The smaller they get, the easier it is to get across all these biological barriers."

Not only are they coming directly from the plastics we use, but we're also especially vulnerable to microplastics and nanoplastics in the environment.

DESPITE BEING SO useful, most plastic has a bewilderingly brief functional life. Currently, virgin plastic is produced at an astonishing rate of approximately 460 million tonnes per year, and a great deal of that is used in packaging or other single-use applications. In fact, about two-thirds of new plastic is thrown away within a month of being used.

So here we are. Of the estimated 12 billion tonnes of plastic that has ever been made, 70 per cent of it has ended up as waste. And most of it is still out there. This is where its durability ceases to be an attribute and becomes a major flaw, says Dr Deborah Lau, who leads CSIRO's Ending Plastic Waste program. "[Plastics] are very practical, but they take a very long time to break down in the natural environment," she says.

For example, high-density polyethylene, which is commonly used in milk bottles, can take anywhere from a few hundred to a few thousand years to degrade. Sooner or later, most of the plastic we discard finds its way into the environment. And although most plastic waste is sent to landfill, it doesn't really stay there forever. Instead, it degrades over time into increasingly smaller microplastics that can seep into the surrounding soil and groundwater. Then there's all the unmanaged plastic waste that never reaches landfill in the first place. Recent research from CSIRO shows a great deal of Australia's unmanaged plastic waste winds up in waterways and coastal areas, especially near urban centres.

When you take a close look at the plastic floating in Sydney Harbour, it doesn't take long to figure out where it's coming from. Horrified by the amount of plastic pollution they saw while travelling the world as boatbuilders, Pete Ceglinski and Andrew Turton came up with the design for Seabin. As the name suggests, it's a bin-like device that you put in the water, which then skims the surface and filters out floating debris. In 2020 they placed several in Sydney Harbour and have since filtered more than 30 billion litres of water and captured more than 22 million plastic items. Some 11 million of those were microplastics.

Identifying the source of plastic pollution is crucial if you want to mitigate it, Pete says, so they analyse the waste they find in the harbour. Turns out, most of it comes from Sydney's streets.

"We're starting to see seasonal patterns," he says. "When Christmas comes around, we start to see more little green fibres or strands, which comes from plastic Christmas trees. New Year's Eve, we'll see fireworks and festivity paraphernalia like plastic wristbands. Around Mardi Gras time, we'll start to see glitter in the harbour. Chinese New Year, we'll start to see fireworks and little red candies." When more than 2 million people congregate in Sydney for the annual Vivid festival, plastic pollution rises by up to 200 per cent.

Elvis wasn't surprised to hear about this and sees similar patterns in his research. "It's a direct correlation," he says. "The major plastics that are being consumed in Australia are the major plastics that we see polluting the environment." ►

Members of Conservation Volunteers Australia clean up plastic litter in Moreton Bay in Brisbane.

THE ENVIRONMENTAL IMPACT of plastic waste has been in the public consciousness for decades. So too has the idea of recycling as a solution. Yet even today, only about 9 per cent of plastic gets recycled.

The reason recycling didn't save us is because it was never meant to. According to the IUCN's Centre for Environmental Law, as far back as the 1980s, recycling was largely promoted by members of the plastics and oil industries as a means of assuaging public concern about pollution despite knowing that most plastics are difficult to recycle.

Professor Ali Abbas, a chemical engineer and the director of the Waste Transformation Research Hub at The University of Sydney, explains why plastic recycling is difficult. It's largely due to the vast array of different types of polymers used in modern plastics. He explains that most recycling systems use mechanical recycling, which physically breaks plastic into smaller and smaller pieces, leaving the polymers mostly intact. These polymers are melted down and made into new plastics. This is fine if you're only recycling one type of plastic where the polymers are all identical. But if you have a mixture of plastics, you get cross-contamination of different polymers and they won't bind well together when you try to form new plastic. The resulting material is often weak and difficult to reuse. "It's very difficult to separate these plastics," Ali says. "It quickly becomes uneconomical."

You also lose quality when plastic waste is contaminated by other materials such as paper or food scraps. Sorting and cleaning further drives up costs. Moreover, because polymers degrade with each round of recycling, plastic can only be recycled a few times. In most cases, it's recycled just once before being sent to landfill.

So, is there any good news? Well, yes. Quite a lot, actually.

First of all, sorting is getting cheaper and more efficient. Recent advancements in this space by CSIRO and others involve the use of robotics and artificial intelligence that can distinguish and separate commingled plastics with high accuracy.

Another option involves getting microorganisms to simply eat plastic. It sounds far-fetched, but there are numerous examples of microbes that have figured out a way to break down synthetic polymers. It's not as big an evolutionary leap as you might think. Sometimes it's just a slight change in an enzyme that was already good at breaking down natural polymers.

Ali himself is particularly interested in fungi, which are known for their resilience. "I thought maybe we can explore how fungi could degrade plastics," he says, explaining that he and his team collected some common backyard fungi and tested it on polypropylene. "Why polypropylene?" he asks rhetorically. "Because [I wanted] a difficult problem to solve! And polypropylene has only a 1 per cent recycling rate."

Left on its own, polypropylene might take hundreds of years to degrade. But under controlled conditions, the fungi degraded it in a matter of days. When a marine fungi species was tested, it worked even better. Ali says it's not necessarily simple to scale it up to an industrial level, but it's certainly possible and something they're working on.

He envisions biological processes like these being used alongside emerging technologies such as chemical recycling, which can break down certain plastic polymers – like PET or polystyrene – into their original monomers. These monomers are then repolymerised to make new materials and this cycle can be repeated multiple times without sacrificing quality.

Gasification is another option. Plastic waste is heated under specific conditions to produce a synthesis gas – or 'syngas' – composed mainly of hydrogen and carbon monoxide. "This gas can be used as a feedstock to produce fuels, chemicals, or even new plastics," says Ali, who is encouraged by the results so far. "We're not wasting the plastics anymore; we're recovering them. The carbon that's in there, we're recovering. The hydrogen we're also recovering, and we're using that for new pathways to make new products and chemicals."

Ali applies systems thinking to his work, which involves "looking beyond individual technologies to understand how problems and solutions fit within the larger system – like an ecosystem, where materials, processes and impacts are interconnected." But because of this interdependence, he says it's important to anticipate unintended consequences during the

PHOTO CREDIT: CONSERVATION VOLUNTEERS AUSTRALIA

SORTING THROUGH THE MESS

It's important to note that while many bioplastics are biodegradable, not all of them are. Conversely, many plastics labelled as biodegradable are not made from plants, but are instead made from fossil fuels. Meanwhile, all compostable plastics are biodegradable, but not all biodegradable plastics are compostable. Just because something is labelled as compostable doesn't mean it will break down in a residential garden bed or compost bin. It's really no wonder consumers are confused.

design process. Currently, chemical recycling and gasification come with trade-offs, including high energy demands and potential release of greenhouse gases or toxic by-products, depending on the feedstock and conditions. That's why he and others are working to improve these approaches, both through innovation and by linking them with renewable energy sources or advanced emissions control technologies. If this works, they could have an important role to play in whittling down all our current plastic waste. However, it won't solve the plastics crisis alone.

"Recycling is dealing with the waste. It doesn't make a deep cut in the generation of waste," Ali says. He explains that there needs to be a big shift in thinking, one with far more emphasis on upstream design, including the design of alternative plastics.

"Alternatives will play a huge role," Sarah says. As far as she's concerned, if the plastics we encounter on a daily basis continue to be made the same way, then we're still stuck with all those health risks. "We need a whole rethink of plastic materials," she adds. The good news is that researchers in Australia and around the world are already fast-tracking the development of safe, alternative materials at scale.

BIOPLASTICS, WHICH ARE also called bio-derived or bio-based plastics, are made from renewable biomass instead of fossil fuels. Biomass is useful because it contains a lot of starches and sugars, which can be broken down to make new polymers. The feedstock can come in the form of renewable crops such as sugarcane, bamboo, corn, soy, canola, sunflowers and more. It can also be sourced from seaweed, microalgae and wood pulp, not to mention the more than 1 billion tonnes of agricultural and food waste the world produces annually.

Sarah sees a lot of promise in bioplastics. "There are some really good candidates," she says. "There's one in particular we're focused on. It's a natural polymer that's made by bacteria. It's called polyhydroxyalkanoate – PHA for short – and you can get big buckets of bacteria and chuck in anything really: waste sugarcane, waste food, you name it."

Turns out, bacteria have been gobbling up starch and pooping out natural polyesters (a type of polymer) for billions of years. Now bioengineers and chemists are harnessing this digestive exuberance to produce better plastics. To toggle the physical qualities of PHA polymers you don't necessarily have to use chemical additives. Instead, you can modify the polymers directly by altering their length or by adding little branches and then tweaking the structure and number of those branches.

Research so far indicates that PHAs are non-toxic, and because of this, they are already being used in a range of medical devices and implants. In fact, production of PHAs is being scaled up for a wide range of commercial uses, with more development underway to both drive down costs and expand potential uses. For example, the Perth-based start-up Uluu uses marine microbes to produce PHA from seaweed that's both biodegradable and compostable, and because seaweed absorbs a lot of CO_2 as it grows, the whole process is carbon negative. Meanwhile, a team of researchers in South Korea just announced they've bioengineered microbes to a strong and flexible polymer with similar characteristics to nylon.

Biomass has more to offer than just starches. Fruits and vegetables contain polyols, which are being used in combination with plant-derived lignin to make bio-based polyurethane. Others are making hard bio-polycarbonate from limonene, found in lemon peel, without the need for additives such as BPA.

Bioplastics are a big focus at CSIRO too, Deborah says. On one level, bioplastics will have very similar chemical properties to current plastics. "They will have a similar ability of flexion or movement in the chain that will give them that plasticity," she explains. "They will quite often be thermoplastic, which means that when we heat them up to a certain temperature, they can be moulded or blown into films."

So far, only 1 per cent of plastics are made from bioderived sources. But as the technology improves and production costs continue to become more competitive, that number will ►

More than 460 million tonnes of plastic is produced every year.

THE NOT-SO-MAGNIFICENT SEVEN

Plastic is classified into the following major categories based on the main polymers used and their properties. The list below includes one common example of each of their uses:

1. PET (polyethylene terephthalate): Water bottles

2. HDPE (high-density polyethylene): Bottles for cleaning products and shampoos

3. LDPE (low-density polyethylene): Plastic grocery bags

4. PVC (polyvinyl chloride): Credit cards

5. PP (polypropylene): Bottle caps

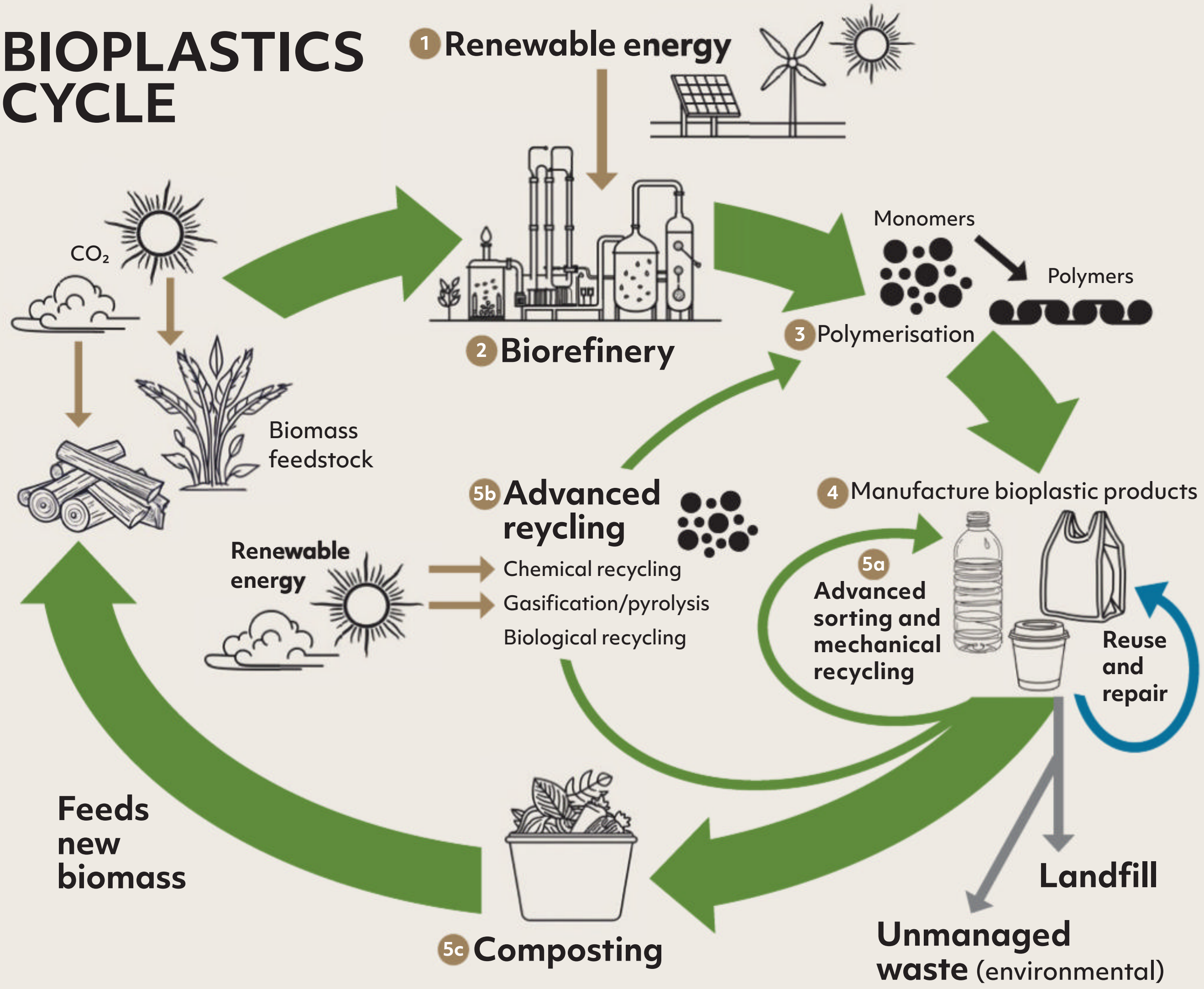
6. PS (polystyrene): Disposable cutlery

7. Other plastics such as nylon, used in clothing

The possible combinations of polymers and additives is virtually infinite. The development of new polymer blends, copolymers and advanced additives continues to expand the range of possible plastic materials.

PHOTO CREDIT: GETTY IMAGES

BIOPLASTICS CYCLE


1 Renewable energy
CO₂
2 Biorefinery
Monomers
Polymers
3 Polymerisation
Biomass feedstock
5b Advanced recycling
Renewable energy
Chemical recycling
Gasification/pyrolysis
Biological recycling
4 Manufacture bioplastic products
5a Advanced sorting and mechanical recycling
Reuse and repair
Feeds new biomass
Landfill
5c Composting
Unmanaged waste (environmental)

Production phase

Step 1: Biomass feedstock. Renewable biomass is grown using sunlight and draws CO_2 from the atmosphere.

Step 2: Biorefinery. Everything goes to a biorefinery, where the biomass is completely broken down.

Step 3: Polymerisation. Monomers (individual molecules) derived from the refined biomass are linked together into polymers.

Step 4: Manufacturing. The polymers are used to make bioplastic products. Ideally, these products are designed to be reused and easily repaired.

Managed disposal phase

Step 5a: Advanced sorting and mechanical recycling. Some products may be disposed of and sorted with AI and robotics. Clean, well-sorted products can be mechanically recycled a few times and made into new plastic products (Step 4).

Step 5b: Advanced recycling. Bioplastic products can be broken down into monomers or even simpler molecules through chemical recycling or thermal processes such as gasification and pyrolysis. These are ideally powered by renewable energy. Some bioplastic products may be biologically recycled, where microbes or enzymes are used to break down plastic into small molecules. Advanced recycling outputs can be used to make new bioplastic polymers (Step 3).

Step 5c: Composting. Some products can be industrially composted. The resulting compost can be used to grow new biomass (Step 1) to complete the cycle.

Unmanaged disposal

With advanced sorting and recycling technologies, the amount of bioplastic ending up in landfill will be far less than the amount of traditional plastic that's currently going to landfill. Still, it's likely that some bioplastic products will end up there, at least in the near term.

It's also likely that bioplastics will end up in the environment due to littering or illegal dumping.

Because bioplastics are designed to break down into naturally occurring molecules within months or a few years – compared to centuries or even millennia for traditional plastics – their environmental impact should be significantly lower.

The Ocean Cleanup is on a mission to rid oceans of plastic pollution by scooping up floating plastic.

THE ORGANISATION AIMING TO GO OUT OF BUSINESS

As Aussie-founded Seabin focuses its efforts on localised waterways such as harbours and marinas, The Ocean Cleanup, a Dutch non-profit, is making significant strides in tackling the Great Pacific Garbage Patch – the largest accumulation of ocean plastic in the world, located between Hawaii and California in the North Pacific Ocean. Its innovative system, consisting of a large U-shaped barrier towed by ships, has successfully removed some 250,000kg of plastic from the patch. As part of its dual strategy, it also deploys Interceptors to capture plastics from rivers, which are the source of most ocean pollution. The organisation aims to eliminate 90 per cent of floating ocean plastic by 2040 and, as stated on its website, to one day put itself "out of business" when our oceans are clean.

rise. Deborah isn't expecting bioplastics to completely replace traditional plastics, though. For now, it's all about triage, she says. This means identifying which traditional plastics have the worst health and environmental impacts and replacing those with well-designed bioplastics. That means bioplastics will be used in single-use food packaging much sooner than they're used in, say, durable industrial pumps that can be sustainably recycled.

If we look at this from a systems perspective, as Ali encourages us to do, it's clear we don't need anywhere near as much plastic as is currently produced each year. Far more plastic is made than is needed. The shift to bioplastics needs to come alongside a shift in the way we think about and use plastic, as well as a shift in policies. Ali explains it's not just the materials that need to be circular; business models need to be circular too. The current business model incentivises disposability and overproduction, but this could be shifted by policies that make companies responsible for their products' downstream impacts.

In other good news, cleantech organisations such as Seabin are eager to continue the clean-up of legacy plastic waste in the environment and expand operations. Pete Ceglinski wants to facilitate the clean-up of coastal waterways in Australia and around the world. They just need the funding.

Seabin Foundation is also focusing on education initiatives to help the public better understand the impact of plastic on the marine environment, how it gets there, and what actions we can take at an individual level and as a community. A broader understanding of our consumption patterns as individuals will be an important part of this, Ali says. This is where sociology and behavioural science can play an important role. Data and digital materials will also help, including QR codes for consumers to scan and read about a product's carbon footprint, what materials it contains and at what levels, as well as where they came from. "These digital passports are emerging out of Europe and other places, and I believe we're going to see them [in Australia]," Ali says. "The consumer pull for sustainable products is going to drive the manufacturers to improve everything they do in terms of design and development of these products, logistics of transport of the products to the consumer – all sorts of important things."

We can be conscious consumers while also using less plastic in general. Elvis says it's a continuous learning curve, even for researchers: "I didn't know that plastic kettles release plastic until I started my work, then I just called my wife and said, 'Hey, let's just go and change the kettle quickly!'"

So, not only does industry need to make critical changes, but consumers do as well, he says. "I tell people it's on us. The little things we do play a major role."

As members of the public, we can advocate for better policies. In 2022 the New South Wales Government introduced a ban on single-use plastic bags, after which Seabin observed a 71 per cent reduction in plastic bags floating in Sydney Harbour. Public campaigns and support played an important role in that, which highlights how collective action can be a powerful magnifier.

Back on Quandamooka country, groups of volunteers have begun gathering regularly to clean up plastic pollution on the shores of Moreton Bay. Among them is Conservation Volunteers Australia. The organisation's involvement is an expansion of its nationwide SeaToSource project, which aims to not only collect litter but also provide education workshops and citizen science training. It's open to any members of the public who want to do their part.

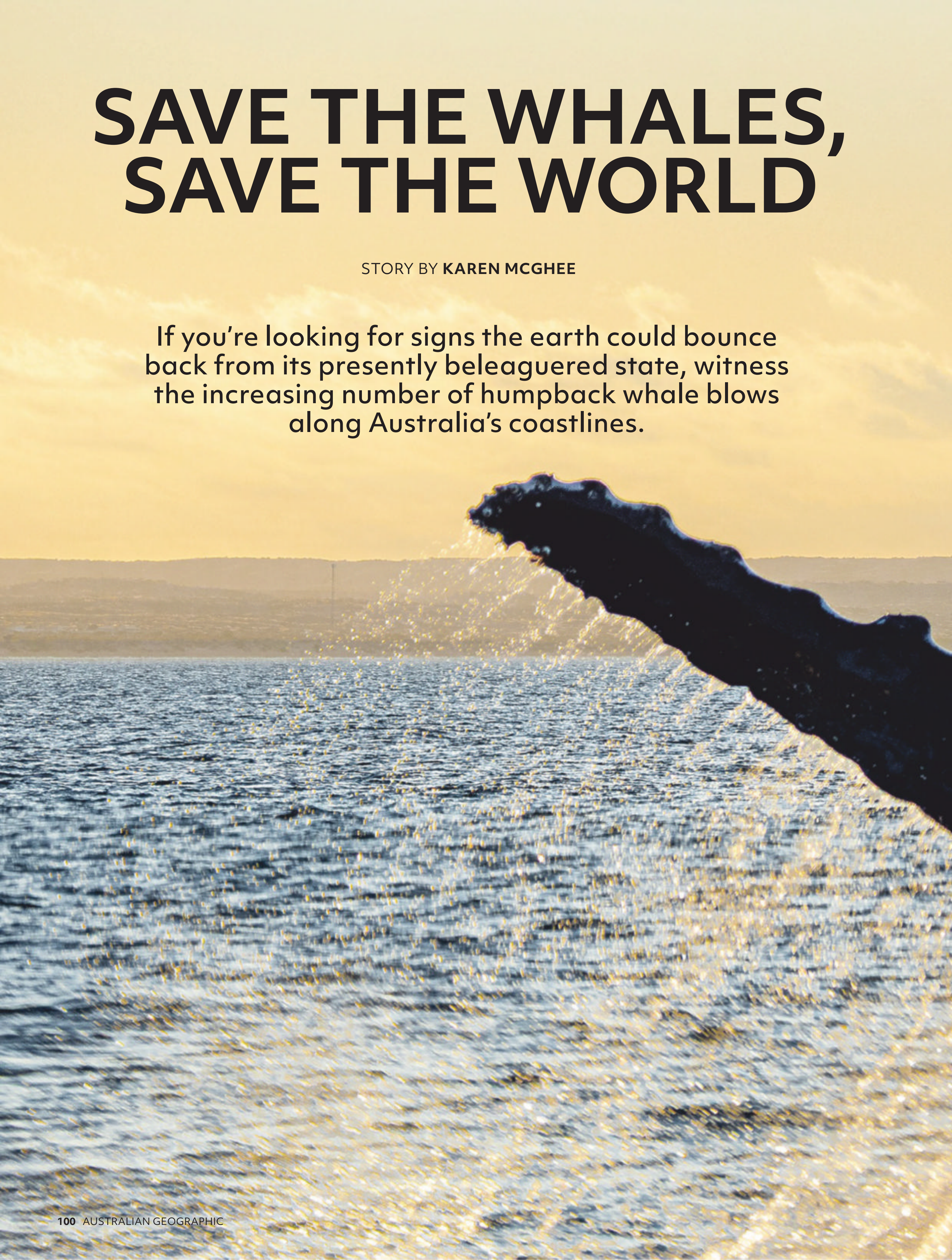
Indeed, we have before us a whole ecosystem of solutions – and it contains multitudes. ■

PHOTO CREDIT: GETTY IMAGES

SAVE THE WHALES, SAVE THE WORLD

STORY BY **KAREN MCGHEE**

If you're looking for signs the earth could bounce back from its presently beleaguered state, witness the increasing number of humpback whale blows along Australia's coastlines.



A humpback whale breaches off the Ningaloo coast in Western Australia.

Photo credit: Holly Matheson

IT'S UNQUESTIONABLY ONE of our planet's greatest conservation success stories – the comeback of the humpback whale (*Megaptera novaeangliae*) from the brink of extinction. And nowhere in the world is it so strongly evident as along the Western Australian coast.

The humpback is a species with a global distribution, but there are two geographically separate and genetically distinct populations – one in the Northern Hemisphere and one in the Southern Hemisphere. In winter, both migrate near coastlines towards calving grounds in warmer waters and return to polar feeding grounds each summer. And both were decimated by commercial whaling during the 20th century. In fact, by the mid-1960s, when whaling of humpbacks ended in WA waters, only a few hundred adults remained in the population that migrates annually along the state's coast.

Today, WA's humpback population could be well over 50,000, but no one is sure. The last accurate scientific estimate of the population was done by husband-and-wife whale researchers Curt and Micheline Jenner in 2008 using mainly aerial surveys, and was reported by them and others in the scientific literature two years later. At that time – more than four decades after the cessation of whaling – the population that migrates along WA was reliably estimated by the Jenners to contain approximately 26,100 individuals and said to be increasing at an annual rate of about 11–12 per cent.

"So, the expectation is that they would have been increasing quite a lot since," explains Professor Chandra Salgado Kent, an Edith Cowan University marine ecologist with expertise in bioacoustics. "But we don't know [exactly] how much, and we don't know if they have reached their carrying capacity [the maximum population an environment can support]."

The Humpback Highway: every year, tens of thousands of humpbacks migrate along the WA coast.

Whatever the real figure is now, there's no question it has been a truly extraordinary outcome for such a long-lived species. Humpbacks have a potential lifespan of almost a century, with females capable, from the age of five to 10 years, of producing only a single calf every two to three years. "We're just waiting now to do the next round of aerial surveys," Micheline says, explaining that should confirm the true extent of the comeback by WA's humpbacks.

In the meantime, these whales have become so numerous off Australia's west coast that the migratory route they take – up to 16,000km return – is known popularly as WA's Humpback Highway, a term first coined by the Jenners in 1990. And that description certainly seems apt during the southward spring-summer migration; a constant stream of these marine mammals file past the coastline after breeding as they head for Antarctic feeding grounds.

"We now know humpbacks migrate from the Southern Ocean, where they feed and then travel up across that ocean and along the WA coastline all the way up to the Kimberley," Chandra says. "As the population has grown, we increasingly have sightings further afield – we're even getting sightings now off the Northern Territory, Indonesia and, recently, Christmas Island."

Not all WA humpbacks travel the entire distance up to the Kimberley. But in the late 1990s the area was recognised as particularly significant for humpbacks when a winter-time nursery site for the species was identified by the Jenners at Camden Sound, about 300km north-east of Broome. Their discovery ultimately led to the establishment of the Lalang-garram/Camden Sound Marine Park in 2012 to help preserve the crucial site. About a quarter of the park's 7062sq.km total area protects a humpback nursery. And the humpbacks that arrive here each year are now recognised as the largest aggregation of the species seen anywhere in the world.

"But there's evidence that humpback births are also occurring [further south], a lot of them off Exmouth as well," Chandra says, adding that occasionally very young calves are now seen off the WA south coast, a long way from the Kimberley calving ground. "It seems that as the population is increasing, it needs to expand its calving areas."

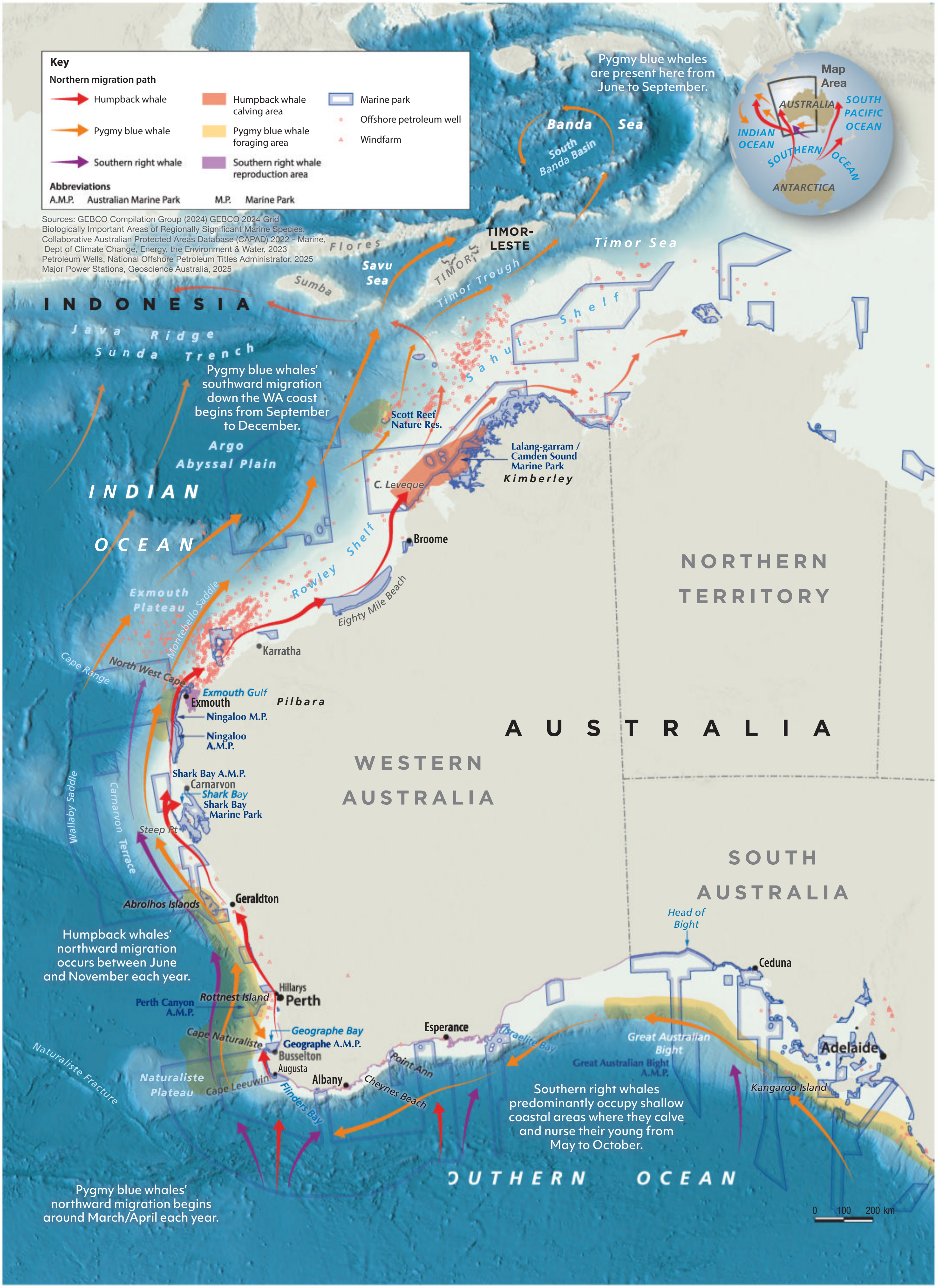
After giving birth in sheltered and safe waters, humpback mothers pause for a while, feeding and fattening their offspring, which are born with no blubber and need to build reserves of this crucial energy source for migration.

Humpback mothers then turn around, calves in tow, and head south to their Antarctic feeding grounds in the Southern Ocean – often attracting the attention of male escorts en route. A male hoping to mate can follow a female for up to two days, but usually only trails her for several hours.

"Females can come into postpartum oestrus within a month, so they can become pregnant within a month of giving birth," Micheline explains. "Generally, they won't – but the males will certainly give it a go!"

Females with calves will often resist the advances of males and fiercely defend their calves during any interactions. "There's ▶

PHOTO CREDIT: SHUTTERSTOCK


Key
Northern migration path
Humpback whale
Pygmy blue whale
Southern right whale
Humpback whale calving area
Pygmy blue whale foraging area
Southern right whale reproduction area
Marine park
Offshore petroleum well
Windfarm
Abbreviations
A.M.P. Australian Marine Park
M.P. Marine Park
Map Area
AUSTRALIA
SOUTH PACIFIC OCEAN
INDIAN OCEAN
SOUTHERN OCEAN
ANTARCTICA
Banda Sea
South Banda Basin
Flores
TIMOR-LESTE
TIMOR
Timor Sea
Timor Trough
Savu Sea
Sumba
INDONESIA
Java Ridge
Sunda Trench
Sahul Shelf
Scott Reef Nature Res.
Lalang-garram / Camden Sound Marine Park
Kimberley
C. Leveque
Argo Abyssal Plain
INDIAN OCEAN
Broome
Rowley Shelf
Eighty Mile Beach
NORTHERN TERRITORY
Exmouth Plateau
Montebello Saddle
Karratha
Cape Range
North West Cape
Exmouth Gulf
Exmouth
Pilbara
Ningaloo M.P.
Ningaloo A.M.P.
AUSTRALIA
WESTERN AUSTRALIA
Wallaby Saddle
Carnarvon Terrace
Shark Bay A.M.P.
Carnarvon
Shark Bay
Shark Bay Marine Park
Steep Pt
SOUTH AUSTRALIA
Abrolhos Islands
Geraldton
Head of Bight
Ceduna
Hillarys
Perth
Rottnest Island
Perth Canyon A.M.P.
Cape Naturaliste
Geographe Bay
Geographe A.M.P.
Busselton
Augusta
Esperance
Israelite Bay
Great Australian Bight
Great Australian Bight A.M.P.
Adelaide
Kangaroo Island
Naturaliste Fracture
Naturaliste Plateau
Cape Leeuwin
Flinders Bay
Albany
Point Ann
Cheynes Beach
SOUTHERN OCEAN
0 100 200 km

Sources: GEBCO Compilation Group (2024) GEBCO 2024 Grid
Biologically Important Areas of Regionally Significant Marine Species,
Collaborative Australian Protected Areas Database (CAPAD) 2022 - Marine,
Dept of Climate Change, Energy, the Environment & Water, 2023
Petroleum Wells, National Offshore Petroleum Titles Administrator, 2025
Major Power Stations, Geoscience Australia, 2025

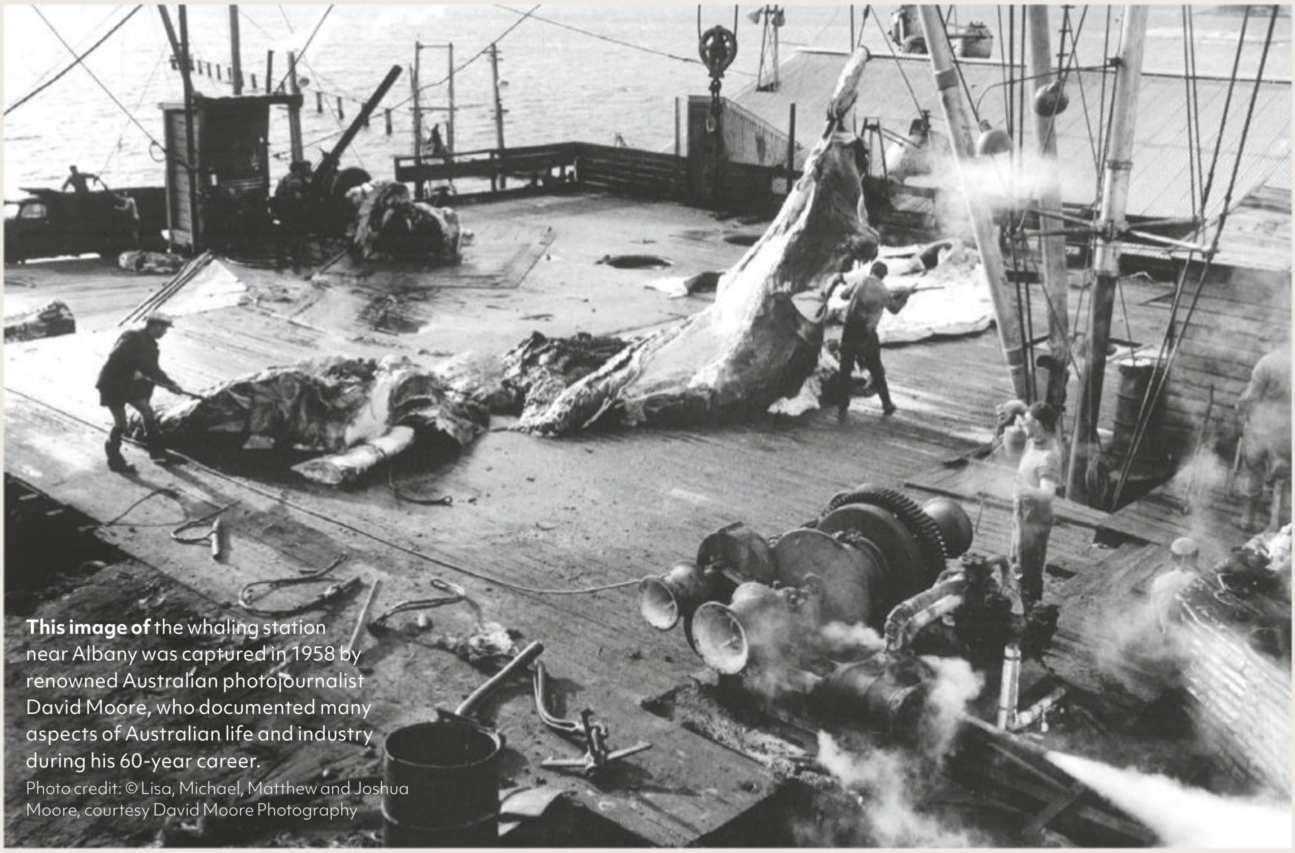
Pygmy blue whales are present here from June to September.

Pygmy blue whales' southward migration down the WA coast begins from September to December.

Humpback whales' northward migration occurs between June and November each year.

Southern right whales predominantly occupy shallow coastal areas where they calve and nurse their young from May to October.

Pygmy blue whales' northward migration begins around March/April each year.



This image of the whaling station near Albany was captured in 1958 by renowned Australian photojournalist David Moore, who documented many aspects of Australian life and industry during his 60-year career.

Photo credit: © Lisa, Michael, Matthew and Joshua Moore, courtesy David Moore Photography

FROM PROFIT TO PRESERVATION

Today, WA's whales are appreciated as highly intelligent mammals with a culture that passes between generations. But in previous centuries, many species were seen as little more than a commodity.

Even before Europeans settled in Australia, American whalers hunted humpback, southern right and sperm whales in Western Australian waters. These mariners continued to arrive after settlement, calling into ports such as Albany, Augusta and Busselton to replenish supplies, and providing an important source of income for early settlers.

Early WA-based commercial whaling began in the 1830s, operating from Albany, Point Cloates and Carnarvon. Albany quickly became the main hub because of its location along the migratory paths of humpback, southern right and sperm whales. In 1952 a whale-processing plant opened just south of the town. Owned by Cheynes Beach Whaling Company, it ran until November 1978, when the last sperm whale was hunted. It was Australia's last-operating whaling station.

Major whale products of the time included:

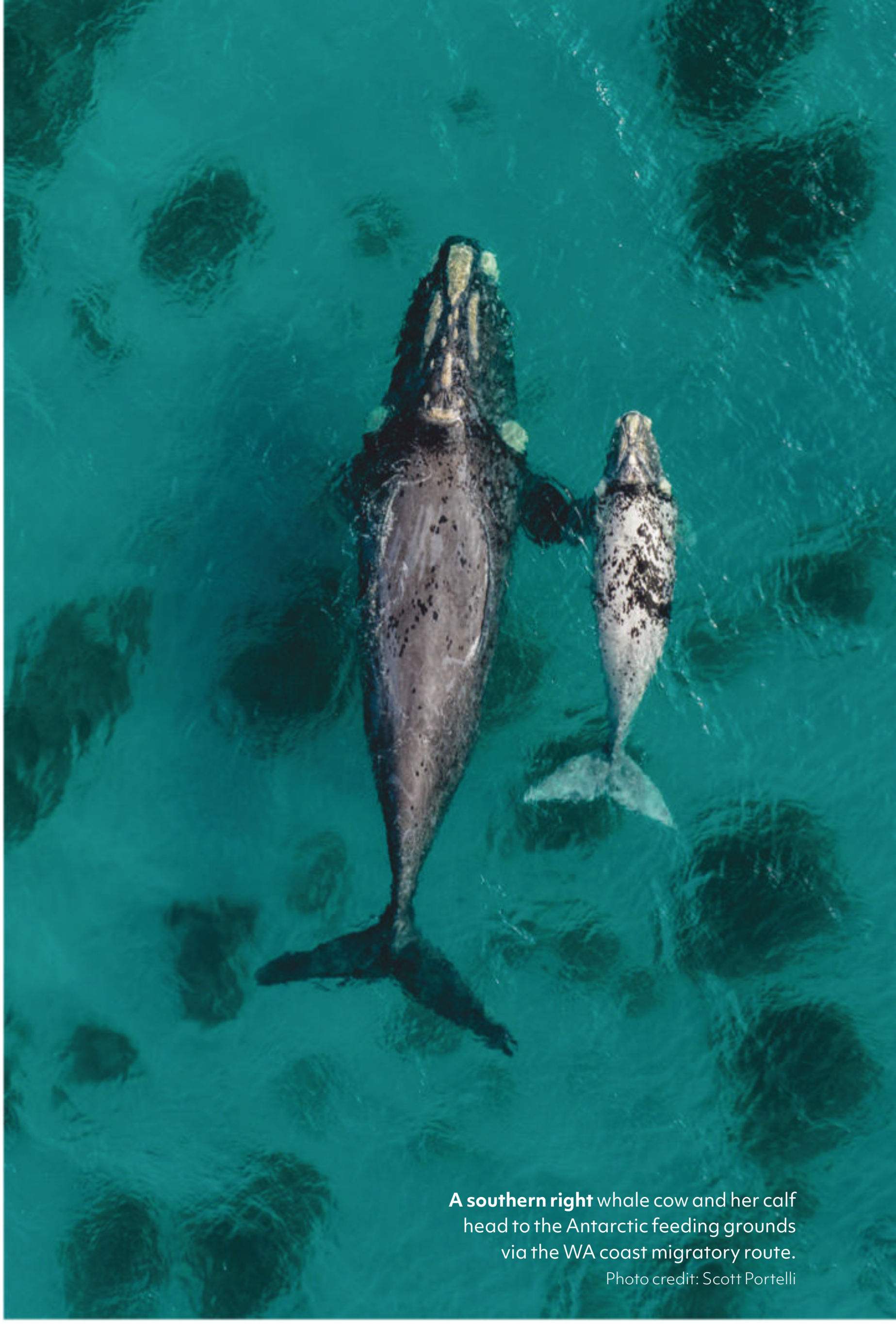
- **blubber oil**, which was used to light lamps, as lubricants, in margarine and for industrial uses;
- **spermaceti oil**, a waxy substance particularly abundant in the heads of sperm whales and prized for use in cosmetics, pharmaceuticals and high-performance machinery;
- **ambergris**, a rare substance from the whale's digestive tract prized for perfume-making;
- **meat**, which was processed mostly for pet food, though some was for human consumption;
- **bone and baleen**, which were historically used in tools, fashion and brushes.

In the 1960s whale oil fetched about $500 per barrel on the global market. Whaling was one of Albany's major industries, supporting livelihoods in engineering, logistics and food processing. At its peak, the Cheynes Beach Whaling Company station near Albany employed more than 100 people, operated up to three whale chaser vessels, and harvested more than 1100 sperm whales a year. Across the state, hundreds more were involved in whaling and its associated industries. Most products were exported to markets in Japan, Europe and the US, although the early shore-based operations also supplied domestic markets.

During the early years of whaling, southern right and humpback whales were the most common targets of whalers due to their high oil yield and habit of swimming near the shore. But by the mid-20th century, whalers shifted to sperm whales for their valuable spermaceti oil and ambergris.

In 1980, just two years after its last whale was processed, the Cheynes Beach Whaling Station reopened as a museum. Today it's known as Albany's Historic Whaling Station in the Discovery Bay Tourism Precinct. The state heritage-listed site has the only intact whaling station in the Southern Hemisphere. It attracts 65,000 visitors a year and remains one of WA's leading tourist attractions. In 2024 it won gold at the Tourism Council WA awards. Its ongoing work preserves this significant, albeit brutal, chapter of WA's maritime, economic and social history.

Not all species formerly targeted by commercial whaling have recovered as quickly.



A southern right whale cow and her calf head to the Antarctic feeding grounds via the WA coast migratory route.
Photo credit: Scott Portelli

no long-term association between the males and females," Micheline says. "The females have 10 to 11 months of gestation, and then they care for that calf for one further year. So, a female will invest two years into the life of her calf. But for the males it may only be hours – males just want to mate with as many females as they can across the season."

It's also now known that humpback mums take time during their southerly migration to pause at safe rest spots to feed and spell their calves. "Nursing females look for quiet spots where there is a lack of stimuli, so the calves aren't revved up by males chasing females or each other," Curt says.

There are many small, protected nooks and crannies along the Pilbara Coast where humpback mothers can rest with their calves while heading south. Exmouth Gulf, the gateway to Ningaloo Reef, and Shark Bay, more than 400km further south, are both renowned as resting spots for mothers and calves on their southerly migration.

The Jenners also believe Exmouth Gulf may be another important calving ground for the species. Curt explains that wintertime conditions in Exmouth Gulf are perfect in terms of temperature and protection for humpback mothers. So now, with expansion of the population post-whaling, it makes sense the area would be emerging as a significant calving area for the species.

"We think also that males go in there to find prospective females [for mating] as well," Micheline adds.

Further south, the Geraldton coast and Abrolhos Islands also provide important rest areas for humpback mothers and calves, as do the waters between Perth and Rottnest Island. From there the next well-known resting location is Geographe Bay, more than 200km south of Perth. From around Cape Naturaliste they begin heading off into the Southern Ocean and then probably don't stop until they reach Antarctica.

"The mums generally don't eat [during] either all or most of the migration," Chandra says. "Although we do have more and more evidence – a lot of it anecdotal – that there is some opportunistic foraging that occasionally happens. But it's not the norm."

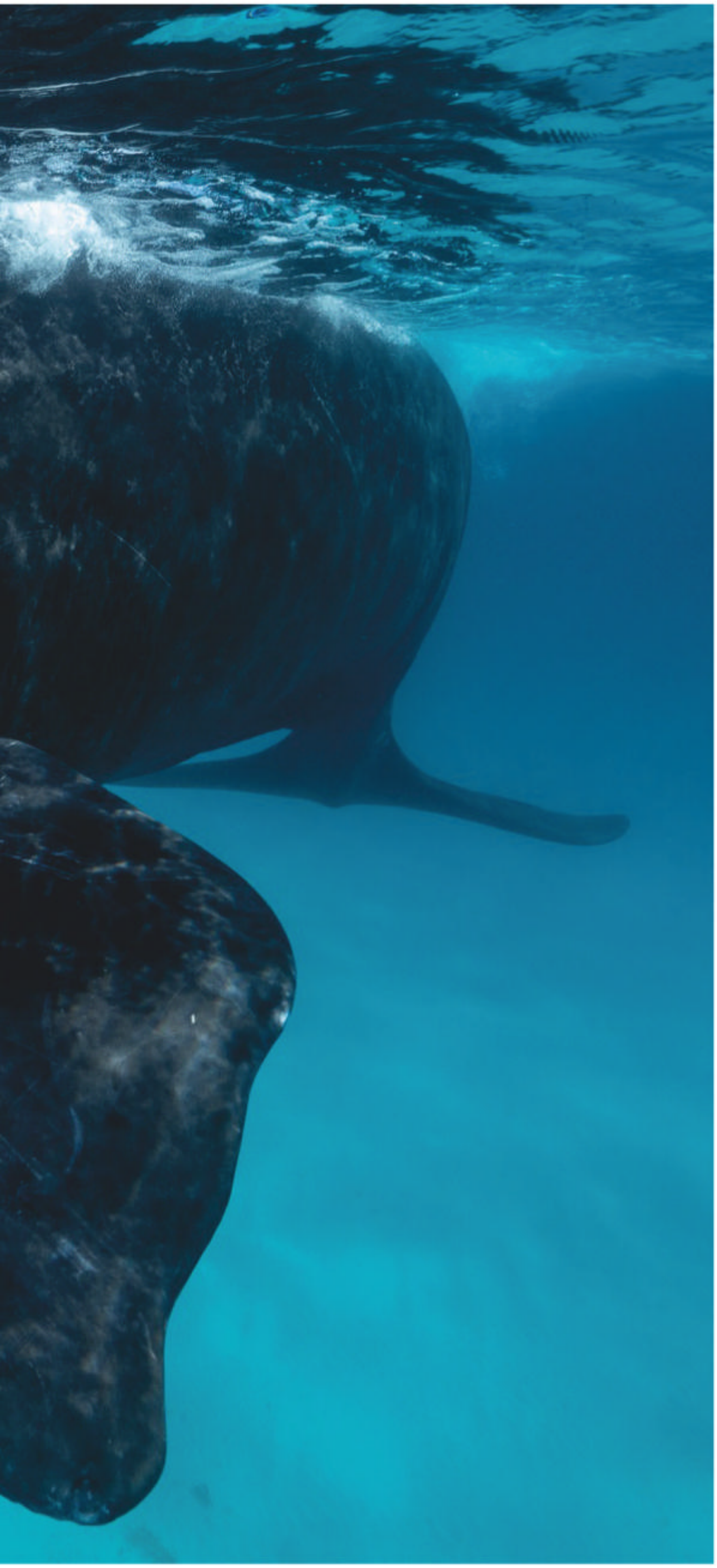
And so, humpbacks feed almost exclusively in the Southern Ocean, mostly on small fish and tiny crustaceans known as krill. Whales filter this prey from the water using baleen plates in their mouths, which act as a sieve. These plates are made of keratin, the same protein found in human hair and nails, as well as in rhinoceros horns.

THE PHENOMENAL RECOVERY of the humpback isn't simply a consequence of the cessation of whaling, and not all species formerly targeted by commercial whaling have recovered as quickly or to such an extent.

"Humpbacks have done really well because they're good at finding and exploiting small patches of prey in Antarctic waters," says Curtin University Professor Robert McCauley, a marine scientist who has studied Australia's west-coast whales for more than four decades

Robert says their feeding success is largely due to their huge pectoral fins. Like the arms of bipedal terrestrial mammals, these stretch out from either side of the upper body and in adult humpbacks can reach lengths of more than 5m each. This is longer than in any other whale species and, in fact, longer than the appendages of any other animal, on land or at sea. ▶

Whale songs can also be specific to populations from different regions, much like accents in humans.



Callosities – thickened patches of skin on the head and jaw – are a distinctive feature of southern right whales, and are formed by whale lice.

Photo credit: Scott Portelli

These huge pectoral fins make humpbacks particularly manoeuvrable in their ocean home, which helps them target prey. In contrast, many of their relatives – such as blue, fin and minke whales – have a more torpedo-shaped body with relatively stubby pectoral fins. "Those whales have to target a patch of prey then come in at speed, open their mouths, then slow right up, take a gulp and accelerate back again," Robert says. "But the humpbacks, having those big pectoral fins, sit there and manoeuvre around to hoover everything up by just opening and closing their mouths continuously."

Humpbacks are also often seen in Antarctic waters working cooperatively when feeding. In these instances, a lead animal is flanked by one or two others that catch krill coming out of its mouth as it feeds.

In addition to the cessation of whaling and a unique physiology, there's another factor that has helped humpbacks bounce back so convincingly. It seems likely that a fair bit of the population's cultural memory managed to survive the whaling years, and that has served WA's humpbacks well.

"These whales tend to come back to the same areas, and we think there were small groups of humpbacks that didn't get completely hunted out," Robert says. "So, there was memory in the population, and they went back to those areas [they knew] so they could meet up and mate, and do all the things they need to do to breed."

ALTHOUGH THE RECOVERY of the humpback has been a huge success story and it's no longer considered endangered in this part of the world, it hasn't been a similar story for other species hunted by commercial whalers in Australian waters. Notably, blue and southern right whales remain listed as endangered.

Blue whales (*Balaenoptera musculus*) have a global distribution, but Southern and Northern Hemisphere populations are separate. Two blue whale subspecies are found off WA: the Indo-Australian pygmy and the Antarctic blue whale. The term 'pygmy' is a bit of a misnomer because it's still a massive mammal – adults grow to almost 25m in length and a weight of about 100 tonnes. Compared to its non-pygmy cousin, however, it's certainly smaller. The Antarctic blue, on the other hand, is truly massive – bigger, in fact, than any other species that has ever lived on earth, including any dinosaur. It grows to almost 35m in length and a weight of about 200 tonnes.

Apart from the size difference, both these blue whale subspecies look very similar, especially when they're glimpsed only fleetingly in the water. But researchers have identified differences in their songs, suggesting that the blue whales found in WA waters are mostly pygmy blues.

Indeed, all whale species have different calls or songs, so it's easy to identify if they're present in any particular body of water even if they can't be seen. Whale songs can also be specific to populations from different regions, much like accents in humans.

The Antarctic blue whale populations that migrate through and stop in WA waters were also decimated by commercial whaling. However, unlike humpbacks, Antarctic blue whales haven't bounced back nearly as well post-whaling. Antarctic blue whales are occasionally found in deeper waters off WA compared to humpbacks. Population estimates are uncertain but are ►

of the order of 5000 or more animals worldwide, compared to approximately 350,000 pre-whaling.

In contrast, pygmy blue whales are regularly seen along the southern Australian, and particularly WA, coastline. "They travel as far north as the Banda Sea [almost 900km north-west of Darwin] in Indonesia, and between Indonesia and Timor-Leste," Chandra says. "We believe that's an important calving area, but we're not sure. Then they go back to the Southern Ocean as well to forage. But blue whales are a bit different [to humpbacks] in that they do feed opportunistically en route. And in some locations, that happens every single year while on migration."

These stopping points are turning out to be so consistent that it's thought blue whales may have regular feeding locations off the WA coast. "One is on the other side of Rottnest, in the Perth Canyon. So, they come and might spend a few days to a few weeks foraging – depends on how much food is there – before moving on," Chandra says. "We think there's probably another [foraging site] off Exmouth. We also think there's perhaps some foraging that occurs off Scott Reef [near the edge of Australia's continental shelf some 270km off the Kimberley coast]. And we have anecdotal evidence that they're foraging off Timor-Leste."

Blue whales are also known to regularly forage off the south-east Australian coast between Kangaroo Island and western Tasmania, an area known as the Bonney Upwelling, which is a notoriously rich and highly productive ocean site.

Robert describes some of the big whale species, such as the Antarctic blue, as "socially lost" post-whaling. By that, he means the population had a long-term loss of cultural knowledge at a population level due to whaling removing the larger experienced adults, and that may explain why they aren't coming back nearly as strongly as the humpback.

"They don't know where they are, what they're going to do, how they find someone else [mates]...so it's taking them a much longer time to recover," Robert says.

Curt adds that the species was also illegally taken by "rogue Russian whalers" in the Southern Ocean, and then along the WA coast all the way up to Exmouth as late as the 1970s. "They've been hammered in terms of whaling for much longer – perhaps two decades more than the humpbacks have...so they haven't recovered anywhere near as well," he says.

The other large marine mammal often sighted off WA is the southern right whale (*Eubalaena australis*). Its name is quite literal and reflects a grim history – it was considered by whalers to be the 'right' whale to hunt. What made it so attractive to whalers is that it swims slower than other species and tends to float after death due to the high concentration of oil and baleen in its body, which made it relatively easy to harvest and handle for commercial processing.

While humpbacks and blue whales feed in Antarctic waters, southern rights feed primarily in subantarctic waters.

There are two subpopulations of the species – west and east coast – that migrate in Australian waters. The west coast population includes animals from SA waters west of Ceduna more than 500km west of Adelaide. The east coast animals occur east of Ceduna, and there are historical records of the species in the waters off all the eastern states.

The western population is far better understood and more intensively researched. An annual census of the west coast population indicates its numbers have been increasing, albeit slowly, post-whaling, which ceased in Australian waters for the southern right in the mid-1930s after the species was granted protection. The earliest documented signs of recovery in the population came in the 1980s, although the comeback has been frustratingly slow.

According to the latest National Recovery Plan for the species, published last year, the western population contains about 3200 animals and is growing at a rate of about 5.5 per cent. The eastern population contained just a few hundred animals post-whaling and has shown no signs of growth.

Southern rights used to be seen along the southern Australian coast in large numbers before commercial whaling and estimates of total numbers for the species were as high as 200,000. The most recent estimate for the combined Southern Hemisphere population is no more than 16,000 – less than 10 per cent of their pre-whaling abundance.

"But small groups survived, and they would go back to their natal beaches, the ones that the females were used to," Robert says. "Those spots are showing recovery, and now we're beginning to see a spillover effect. The Head of the Great Australian Bight is a good example, because now it gets to the point where it fills up [with southern rights]. So, then they start turning up in adjacent bays, and we're seeing those now increase as well."

The Head of the Bight is perhaps the best-known calving location for southern rights in SA waters, while Point Ann is the best-known off south-west WA.

"We're seeing increasing numbers come up towards Perth and as far as Hillarys [Boat Harbour, about 20km north of Perth], although it's only a few," Chandra says. "And Geographe Bay is increasingly now being used as a calving area and by males looking for opportunities to mate."

But Flinders Bay, just south of Augusta on the south-western coast of WA, is the area that's been used more consistently for calving in this part of the species' distribution.

The pygmy blue whale can reach a length of almost 25m.
Photo credit: Tiffany Klein/ Ningaloo Aviation

"We certainly have our work cut out for us to ensure…the other species come back."

Southern right whales often have white patches that can help to identify individuals.
Photo credit: Scott Portelli

"And along the southern coast of Western Australia there are other key aggregation locations," Chandra says. These include Cheynes Beach east of Albany, the waters off Fitzgerald River National Park, and a calving area at Israelite Bay east of Esperance.

Recently, however, Chandra says there has been a "worrisome" and inexplicable slowing down of the species' recovery. That undoubtedly relates to a concerning and so far unexplained recent feature of reproduction in WA's southern rights: a shift in the calving rate. Southern rights normally calve every three years. "But now we're seeing the females calve at three to five years," Chandra says. "And we don't know why."

ONGOING THREATS POST-COMMERCIAL whaling are huge for all species. Climate change is a big one, particularly because warming ocean waters can impact and reduce their prey. Coastal wind farms and other large constructions along whale migration routes are another emerging threat and source of potential conflict, although these are like a giant experiment in progress where we don't know what will happen.

Entanglement in fishing apparatus is also a problem because it can lead to infections and physically restrict the animals' movements and behaviours. Ship strikes are a potential issue for all whales, but for blue whales they're particularly problematic because they can be slow to respond to a large ship's presence. "They either respond at the last minute or not at all," Chandra says. "And there are a range of underwater noise impacts that can cause hearing impairment or [that can] stress or mask communications between whales."

As the populations of these large whales grow, so does their interaction with humans, particularly in areas where human populations are also increasing. This too has led to heightened concerns about potential impacts.

Researchers are working hard to educate people to enjoy these huge marine creatures while also keeping their distance as their populations come back from the brink of extinction. It's particularly critical in calving and resting areas for mothers and calves, where the mothers are trying to fatten and strengthen calves for the rigours of their Southern Ocean journey ahead of them. Unnecessary stimulation does not help them; it's recommended that boats stay at least 300m away from the front and back of a whale, and 100m from its sides. At least one study has shown a significant decrease in suckling rates of calves in response to loud underwater noises and boats that come too close.

"So, while it's heartening to see the recovery story for humpbacks, there are other pressures that are increasing," Chandra says. "And we certainly have our work cut out for us to ensure that we see the other species come back." ■

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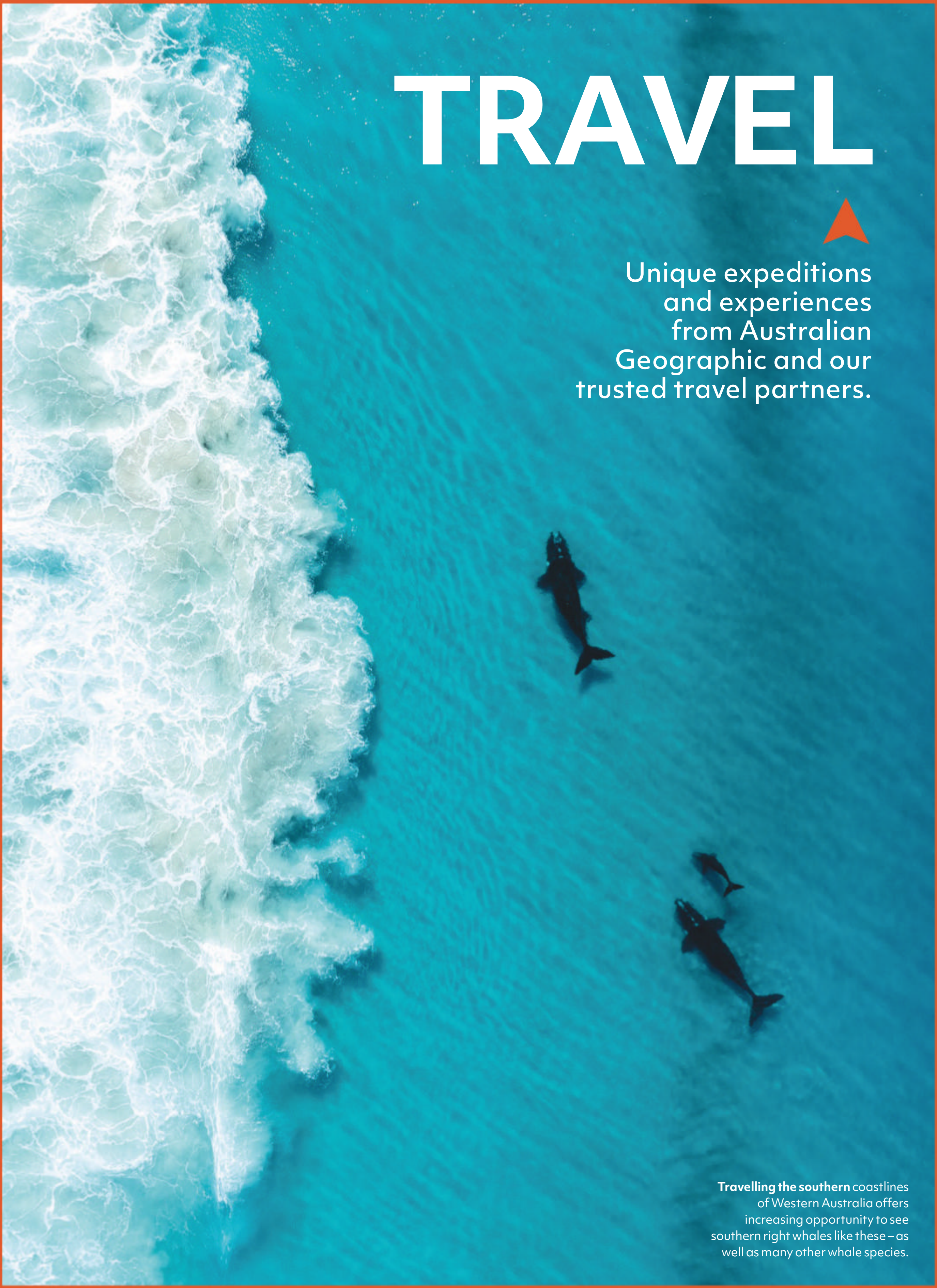


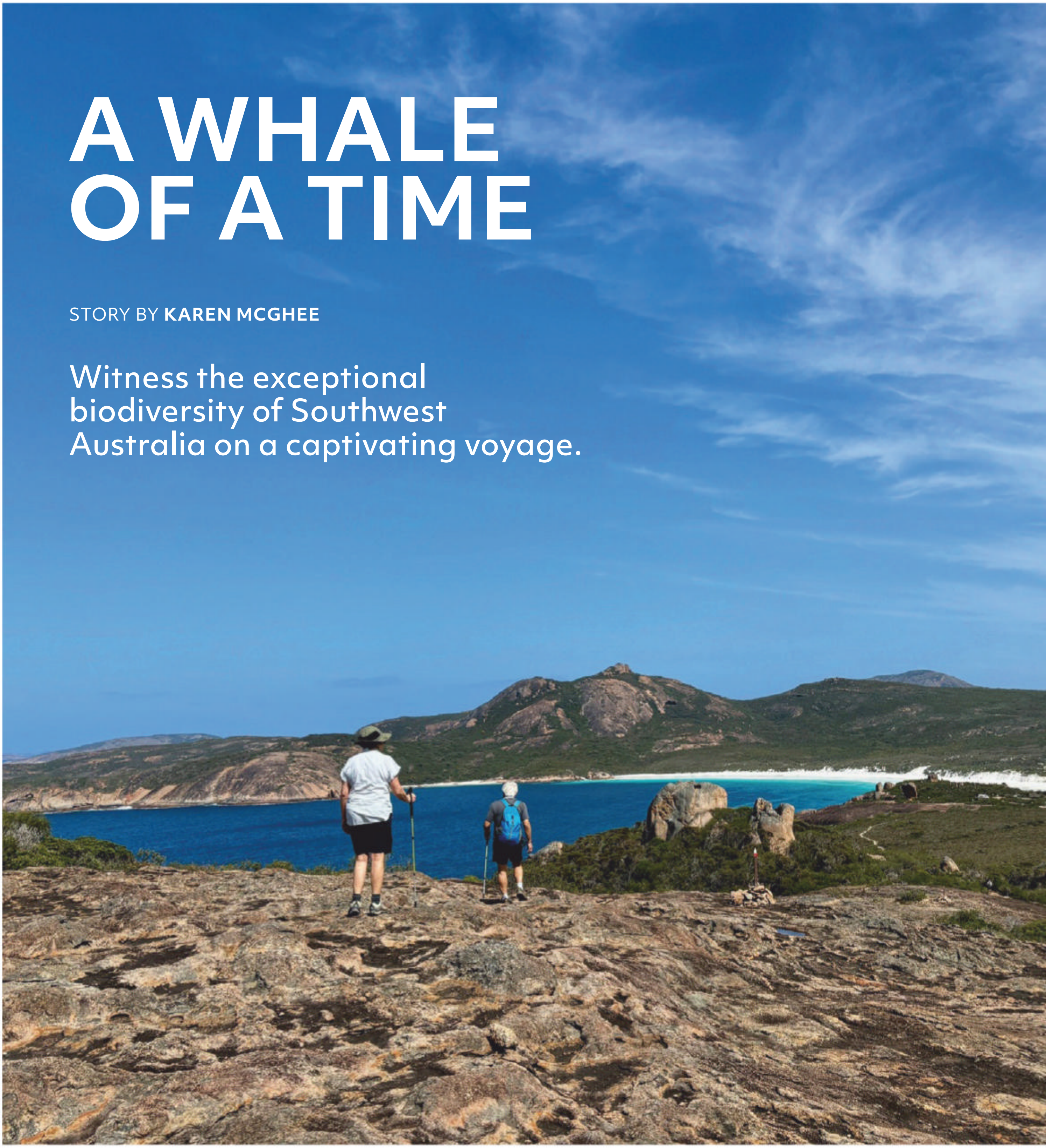
Travelling the southern coastlines of Western Australia offers increasing opportunity to see southern right whales like these – as well as many other whale species.

PHOTO CREDIT: SCOTT PORTELLI

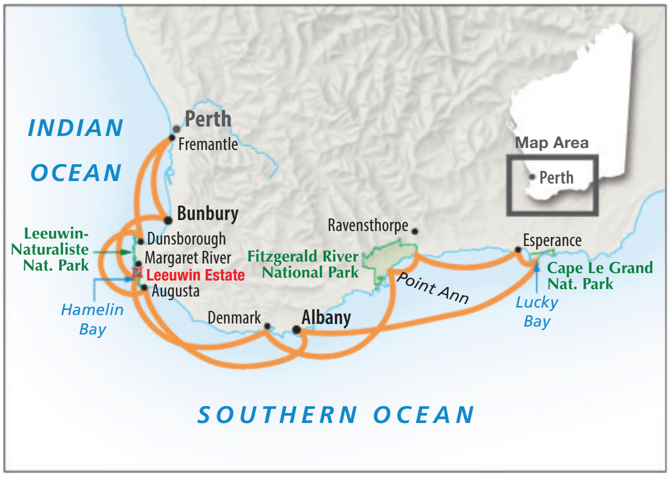
A WHALE OF A TIME

STORY BY **KAREN MCGHEE**

Witness the exceptional biodiversity of Southwest Australia on a captivating voyage.



Hikers make their way towards secluded Thistle Cove in Cape Le Grand National Park.


INDIAN OCEAN
Perth
Fremantle
Bunbury
Leeuwin-Naturaliste Nat. Park
Dunsborough
Margaret River
Leeuwin Estate
Augusta
Hamelin Bay
Denmark
Albany
Ravensthorpe
Fitzgerald River National Park
Point Ann
Esperance
Cape Le Grand Nat. Park
Lucky Bay
Map Area
Perth
SOUTHERN OCEAN

AS ONE OF the world's biodiversity hotspots, Western Australia's south-west is a must-visit destination for anyone interested in nature and conservation. So, when long-time Australian Geographic supporter Coral Expeditions invited me to be a host on one of its voyages through that part of the world, I naturally jumped at the chance.

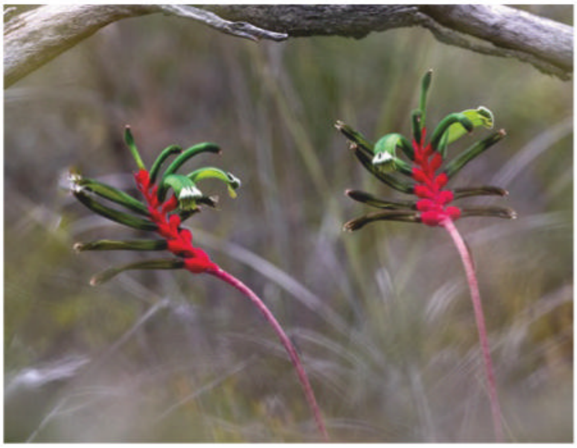
Taking up opportunities like this also provides the chance to discover people, places and events that I think might be worth delving into further for possible feature stories for this magazine. And that's exactly what happened when, last October, I joined the *Coral Adventurer* on a voyage called Whales and Trails.

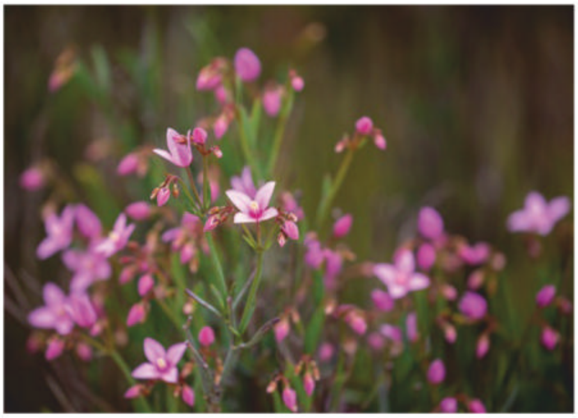
From the moment we set off from the port of Fremantle, steaming south along the coastline and eventually eastwards towards Lucky Bay just past Esperance, whales seemed to be everywhere in the waters around us.

I grew up with the mantra 'Save the Whales' ringing in my ears, an all-encompassing catchcry that embodied efforts to meet the biggest conservation issues of our time head-on. As this trip revealed so spectacularly, we have, in fact, managed to Save the Whales – well, to some extent (see page 100).

When we set sail, humpback whales were on the Antarctica-bound part of their annual migration, and for much of our journey we saw a steady stream of mothers and calves followed by eager males looking for a chance to mate. There were many sightings of breaching and fin-slapping. We even saw the now much-rarer southern right whales and pygmy blue whales close to Australia's southern coastline. Mich, our onboard whale expert, noted that on one of her previous voyages, a rare Antarctic blue whale had been seen in Southwest Australian waters, reinforcing the rich biodiversity of the region.

Mich is Micheline Jenner AM, wife of Curt Jenner AM, both Co-Principal Investigators for the WA Centre for Whale Research. This couple has played a massive role in whale research and conservation in Australia for more than three decades, and the knowledge Mich shared with everyone onboard made the journey an extraordinarily insightful travel experience. A master communicator, every one of Mich's onboard lectures was packed out by guests. ►





On-board botanical expert Kate Cranney (pictured left) and guest traveller Pauline Atkinson inspect a prickly moses wattle (*Acacia pulchella*) on a walking track at Manea Park (above) in Bunbury, WA. Red and green kangaroo paw (*Anigozanthos manglesii,* top right) and winged boronia (*Boronia alata*, bottom right) were also seen on the walk

It was a similar story for onboard botanical expert, Kate Cranney. Not only was Kate particularly knowledgeable in her field of expertise, but – like Mich – she was also a master at communicating serious science in an accessible way.

Other valuable educational insights provided onboard the *Coral Adventurer* included talks by the chief engineer Syed Zaidi in the engine rooms, and on the Captain's Deck with Captain Matthew Fryer. These sessions were also fully attended and offered further fascinating insights into navigating such a rugged coastline.

BACK TO THE biodiversity hotspots. Identified and designated by Conservation International, there are 36 of these special places recognised worldwide, including two in Australia: Southwest Australia, in WA, and the Forests of East Australia, in Victoria.

Plants and the communities they form are key features underpinning what makes these places significant. The biodiversity hotspots have quite precise defining scientific features but, essentially, they are places of extraordinarily high biodiversity, much of which occurs nowhere else – and they face a very high level of threat. These places are of huge ecological value not just to Australia but also globally.

The Southwest Australia hotspot, for example, contains more than 7320 different plant species, 80 per cent of which are found nowhere else on earth. By way of comparison, the whole of England contains some 1500 plant species, about 47 of which are found only there.

Our voyage offered guided walks on land almost every day, and Kate found and identified key plants for us to see along the way. This included several species of ground orchid (*Caladenia* sp.), the carnivorous Albany pitcher plant (*Cephalotus follicularis*) and pink rainbow sundew (*Drosera menziesii*), winged boronia (*Boronia alata*), scarlet banksia (*Banksia coccinea*) and many more.

We travelled during wildflower season, and by the end of the trip we had seen most of the 30 different species of wildflower blooming at that time in this part of the world. Our land-based hikes included part of the famed Cape to Cape Track at Augusta; a regrowth karri forest at Harewood Forest, near Albany; and a hike to Thistle Cove at Cape Le Grand National Park.

NOT SURPRISINGLY, ALL this rich biodiversity underpins a rich human culture. At the town of Albany, famed for its whaling history, we had the option of visiting the state heritage-listed Historic Whaling Station, one of WA's biggest tourist attractions. While some members of the tour visited the station, others were given an insight into local Indigenous culture by local Menang people on a walk to nearby Quaranup.

Of course, this part of the world is also a true haven for foodies, and our voyage on the *Coral Discoverer* certainly celebrated that culinary excellence. Much of the food and wine onboard was supplied by local producers. On one particularly memorable afternoon we dined on the foreshore at Augusta, where we ate freshly shucked Margaret River oysters and drank superb local wines.

On our final night before returning to Fremantle, we boarded the tenders for one last excursion to the shore. After pulling into the Old Dunsborough Boat Ramp, we hopped on a couple of coaches and headed for a gala dinner at the world-renowned, historic Leeuwin Estate for an exquisite final meal featuring local gourmet delights.

The adventure may have ended, but the lessons and memories from this incredible region will stay with us long after our return home. ■

These places are of huge ecological value not just to Australia but also globally.

The *Coral Adventurer* (left) waits in Lucky Bay as guests explore onshore (below). A southern right whale 'waves' its tail fluke in waters off Albany (above).

PHOTO CREDITS: COURTESY CORAL EXPEDITIONS

Conduct reef surveys for The University of Queensland's CoralWatch program.

CORAL FUTURES EXPEDITION

A once-in-a-lifetime experience presented by the Australian Geographic Society.

THE AUSTRALIAN GEOGRAPHIC Society and Great Barrier Reef Legacy have partnered with Coral Expeditions to deliver a unique and immersive citizen science expedition on Australia's Great Barrier Reef.

Sailing aboard the yacht-like vessel *Coral Discoverer*, a small community of 64 like-minded travellers will join marine scientists in exploring the reef while contributing to meaningful action to preserve the ocean's biodiversity.

The expedition will be led and hosted by the Australian Geographic Society's 2024 Awards for Nature gold-tier winner, Dr Dean Miller, and supports the Forever Reef Project. The project aims to collect all 415 hard coral species of the reef, safeguarding them in a living biobank in its purpose-built premises in Port Douglas.

Throughout the journey, we'll visit pristine outer-reef sites where our guides will share insights into coral species and you'll help identify corals for the biobank.

The expedition also features an exclusive walk-through of the 'coral ark' facilities – with a donation to the project included in the trip cost.

Guests will learn from renowned marine geologist and bathymetrist Dr Robin Beaman, who is using various advanced technologies to map the sea floor beneath the reef. Dr Beaman will interpret the 3D modelling for us, revealing detailed features of the sea floor and contributing to research on submarine canyons, submerged reefs, mesophotic coral ecosystems and more. The work enhances our understanding of seabed habitats and evolution and will support various marine studies and scientific programs.

Additionally, you'll conduct daily species surveys as part of the Eye on the Reef conservation project. You'll also learn about the threats and resilience of the Great Barrier Reef from our knowledgeable experts.

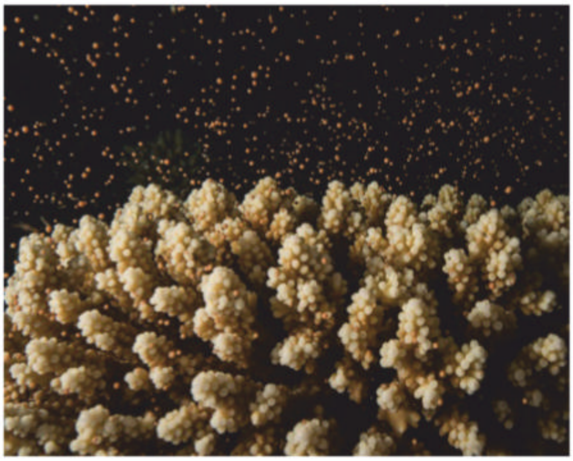
The voyage includes a full-day trip at the renowned sanctuary of Lizard Island, where we'll participate in a remote beach clean-up, hike to the summit of historic Cooks Lookout and enjoy snorkel excursions over the majestic giant clam gardens and seagrass beds to view feeding turtles.

Warm waters and seasonally low wind patterns known as the 'doldrums' combine to provide ideal conditions for the annual mass spawning release of coral eggs and sperm from thousands of colonies. We'll be visiting during the best possible time to witness this annual natural wonder and participate in a controlled night snorkel experience in the pristine Ribbon Reefs.

On board the *Coral Discoverer*, you'll enjoy a personal and relaxed atmosphere shared with like-minded explorers and experienced, friendly crew. You'll be served freshly prepared meals made from ingredients sourced from the region, and drink

PHOTO CREDIT: GRUMPY TURTLE/GREAT BARRIER REEF LEGACY

Discover the incredible biodiversity of the Great Barrier Reef on a glass-bottom boat tour (right) and learn about the conservation efforts underway at the Forever Reef Project's coral biobank (below). You may even witness the spectacular coral spawning event (below right).



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craft beers, artisanal spirits and wines from Australia and New Zealand's finest terroirs.

Proceeds from the voyage will go towards these and other worthy conservation projects supported by the Australian Geographic Awards for Nature. Learn as you explore, and enjoy activities including snorkelling, diving, coastal hikes and birdwatching. Settle back at the end of each day to enjoy the sunset and drinks with new friends.

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About 200 bird species have been recorded inside Gluepot Reserve, including the striated grasswren.

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Travel to some of the best birding hotspots in South Australia and central Queensland.

THIS UNIQUE tour takes you deep into Australia's most remarkable private conservation reserves for an unforgettable birding experience. Explore Gluepot Reserve, a pristine hotspot owned by BirdLife Australia, where sightings may include the striated grasswren, malleefowl, red-lored whistler and even the dazzling scarlet-chested parrot. Our journey culminates at Bowra Sanctuary, a premier birding destination in central Queensland managed by the Australian Wildlife Conservancy. Here, highlights include the chestnut-breasted quail-thrush, Bourke's parrot and the elusive grey falcon, along with sightings of the Australian bustard, inland dotterel, and vibrant orange and crimson chats.

HIGHLIGHTS

- Visit Gluepot Reserve, a 54,000ha reserve in South Australia owned by BirdLife Australia and managed and operated by passionate volunteers. The reserve is home to about 20 nationally threatened bird species, as well as 53 reptile species and 12 bat species.
- Explore Bowra Wildlife Sanctuary in Cunnamulla in central Queensland. The site is owned and managed by the Australian Wildlife Conservancy. This reliable birding site boasts more than 200 species, including the Bourke's parrot and Hall's babbler.
- Enjoy slow-paced travel with an experienced and knowledgeable wildlife guide.

PHOTO CREDITS: COURTESY BELLBIRD BIRDING TOURS

Eagle-eyed birders may spot a pink cockatoo (left) and spiny-cheeked honeyeater (above) inside Bowra Wildlife Sanctuary (below).

DEPARTURES & FARES

Duration: Eight days

Group Size: Maximum seven people

Activity Level: Easy to moderate

Departing:
10 May 2026
19 May 2026
30 August 2026
9 September 2026

Prices:
From $8490pp twin share
From $9390pp single

EXPERT GUIDE
Martin Allen

Martin came to Australia from the UK in 2008 and now lives in Sydney. He has enjoyed wildlife since he was a young lad, but a trip to Costa Rica in 2002 ignited his passion for birds. He particularly enjoys bird photography and works as a casual bird keeper at a zoo when not leading birding tours around Australia.

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GREAT BARRIER REEF TURTLE CONSERVATION

Join an unforgettable adventure on Heron and Wilson islands.

This Australian Geographic Travel exclusive tour offers an immersive exploration of Heron and Wilson islands, famed for their vibrant coral reefs and rich marine life. On this trip, led by marine conservationist and naturalist Susy James, you'll gain a unique insight into island ecology and the critical conservation efforts on the Great Barrier Reef. Despite its small size, Heron Island is home to a significant number of fish and coral species. The tour includes participation in the CoralWatch citizen science program and an exclusive behind-the-scenes look at ongoing research at the Heron Island Research Station.

HIGHLIGHTS

- This exclusive tour is led by an Australian Geographic Travel specialist marine and nature conservation guide.
- Experience nature at its best on Heron Island, world-famous for its spectacular coral reef and extraordinary variety of marine life.
- Snorkel off one of the stunning beaches and onto the Great Barrier Reef.
- Join your guide for nature walks, reef walks and stargazing.
- Participate in the CoralWatch citizen science program and enjoy behind-the-scenes access to Heron Island Research Station.
- See green turtles and loggerhead turtles nesting on beaches.
- Spend two nights on Wilson Island.

EXCLUSIVE
Monitor green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) nesting.

EXPERT GUIDE

Susy James

Susy is a CoralWatch ambassador and Reef Check Australia surveyor with a deep passion for ocean conservation. When she's not travelling and working on the Great Barrier Reef, Susy spends her time volunteering for various marine organisations in Byron Shire in northern New South Wales, where she resides.

DEPARTURES & FARES

Duration: Six days

Group Size: Maximum 10 people

Activity Level: Easy to moderate

Departing:
3 November 2025
1 December 2025

Prices:
From $5490pp twin share
From $7290pp single

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DEPARTURES & FARES

Duration: Six days

Group Size: Maximum eight people

Departing:
23 September 2025
12 October 2025
Private dates available

Activity Level:
Easy to Moderate

Prices:
From $3290pp twin share
From $4190pp single

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EXPLORE THE NARRABRI REGION

Walk in the footsteps of the Gamilaroi people along the short Sandstone Caves walking track in Pilliga Nature Reserve in North West New South Wales. You'll pass through scenic forest to impressive sandstone hills, some of which feature ancient Aboriginal rock engravings. Take some time to read over the interpretive signage for more of an insight into this place that is so special to the Gamilaroi people. Please be respectful when visiting the area and refrain from touching the rock art and engravings.

CONTACT US TODAY

explorenarrabriregion.com.au **02 6843 4011**

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AUSQUIZ

How much do you really know about Australia? Test yourself!

1 **What is Australia's largest native land mammal?**

2 Who was named Australian of the Year in 2025?

3 **Karijini National Park is located in which state or territory?**

4 Is the greater bilby an omnivore or herbivore?

5 **What is Victoria's highest peak?**

6 True or false: Superb lyrebirds are native to Tasmania.

7 **Which state or territory has the largest area of mangrove forest in Australia?**

8 Who was Australia's Prime Minister from 1991 to 1996?

9 **What is the Nyoongar name for Perth?**

10 The Big Golden Guitar is located in which New South Wales town?

11 **Wattles belong to which genus of plants?**

12 Who are the Traditional Custodians of Alice Springs and surrounds?

13 **St Vincent Gulf in South Australia is bordered by which two peninsulas?**

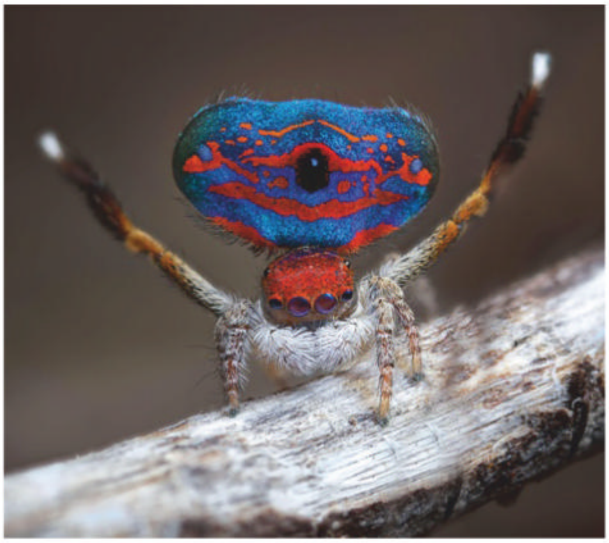
14 The Murray–Darling Basin spans how many states and territories?

15 **What was Australia's first action in World War I?**

16 What colour are the flowers of mulga trees?

17 **What is the southernmost point of mainland Australia?**

18 Which Australian banknote features Mary Reibey and Reverend John Flynn?



19 **In 1982 protesters led a campaign to stop the damming of which Tasmanian river?**

20 Is Lord Howe Island closer to New South Wales or Queensland?

21 **Which Australian aviator was the first to pilot a plane across the Pacific Ocean?**

22 What do phascogales live in?

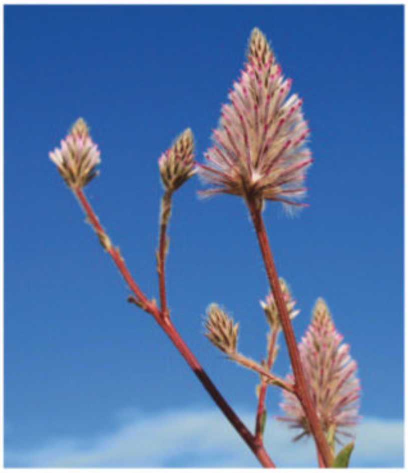
23 **Which Australian author wrote *Cloudstreet* (1991)?**

24 What was the name of the first European settlement in Western Australia?

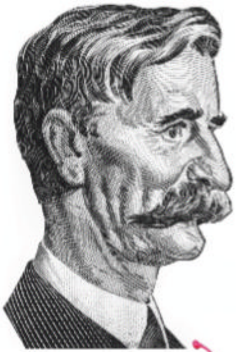
25 **What treaty did Australia, New Zealand and the United States sign in 1951?**

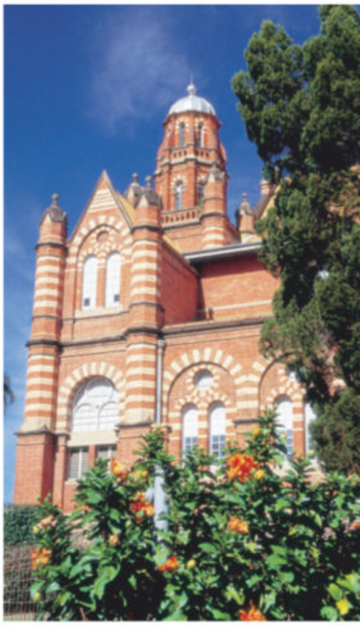
26 Who is Australia's most decorated Olympian?

27 ***Ptilotus exaltatus* (pictured below) is more commonly known by what name?**



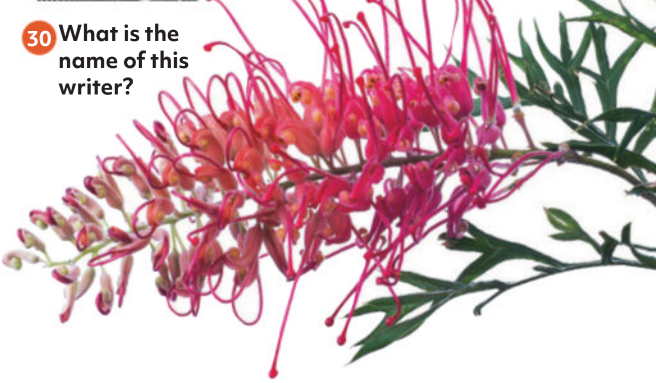
28 **What is the common name of this spider?**



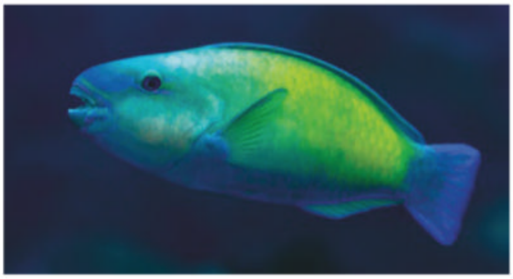


29 **What is the name of this building in Brisbane?**

30 **What is the name of this writer?**



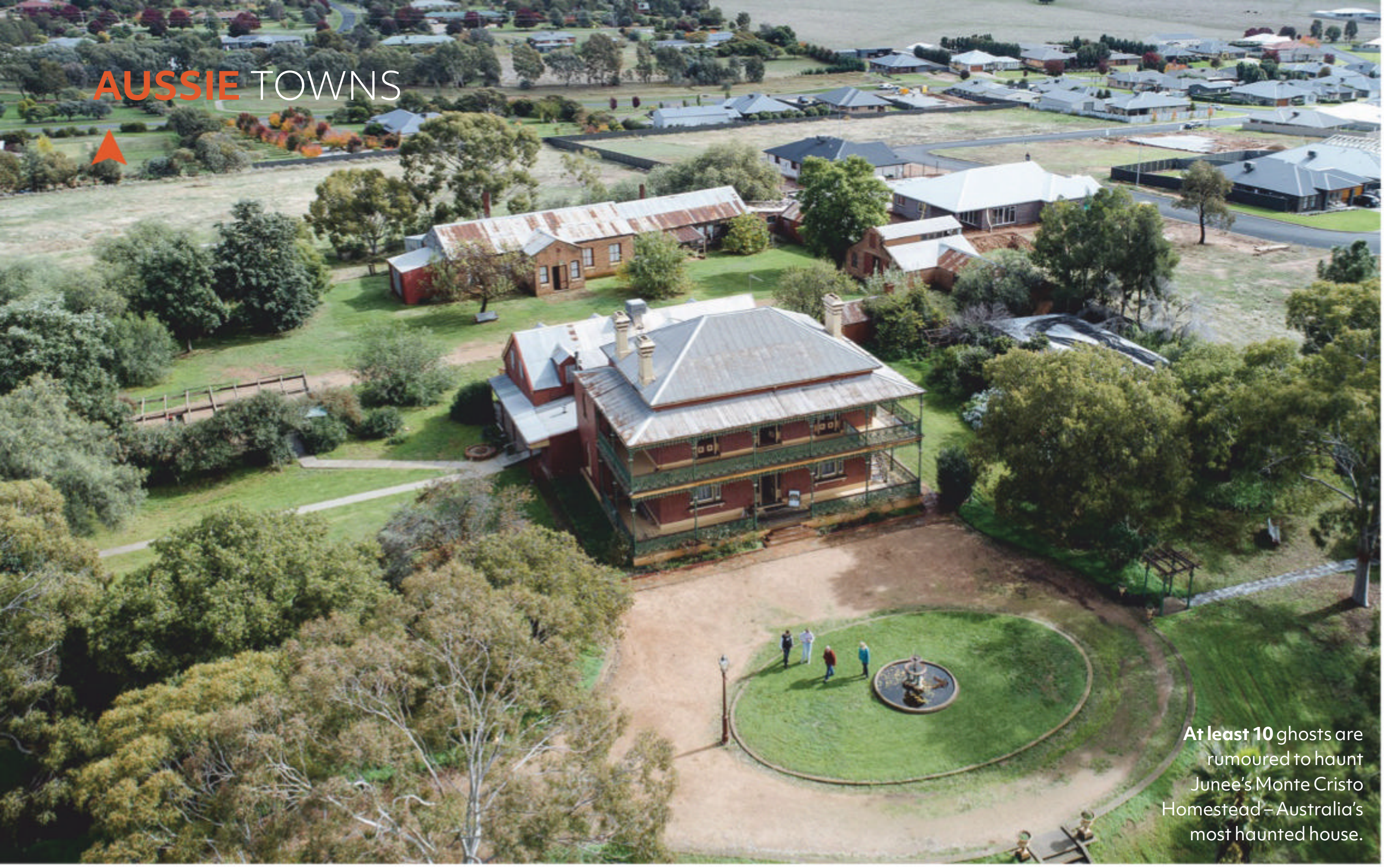
31 **Which genus does this plant belong to?**



32 **What is the common name of this fish?**

FOR ANSWERS See page 128 ▶

PHOTO CREDITS, CLOCKWISE FROM TOP: ALAMY; TOURISM AND EVENTS QUEENSLAND; SHUTTERSTOCK; ALAMY; ALAMY; SHUTTERSTOCK



At least 10 ghosts are rumoured to haunt Junee's Monte Cristo Homestead – Australia's most haunted house.

Junee, NSW

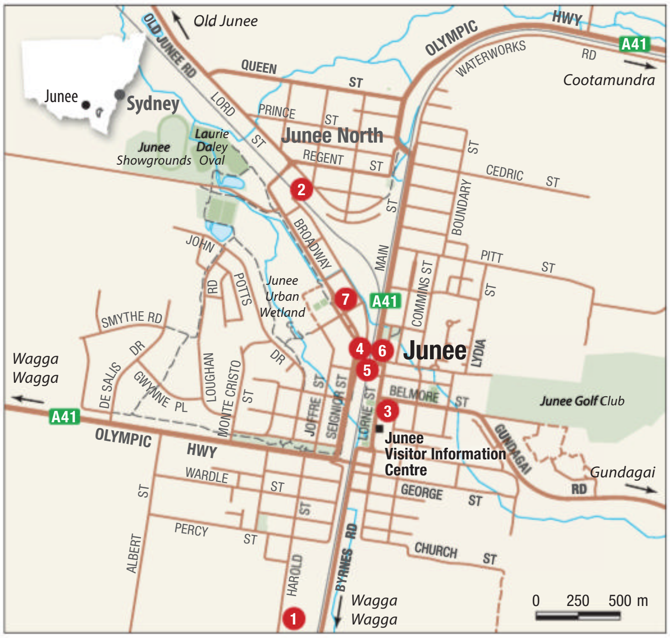
The spine-tingling ghost stories associated with this 19th-century town are world famous.

JUNEE IS A railway town with a charming, old-fashioned ambience. It has elegant streets, well-preserved historical buildings with wide verandahs, and a railway station that dominates the town centre. It's in the South Western Slopes bioregion of New South Wales, a rich and productive agricultural area that produces canola, wheat, oats, olives, barley, wool and fat lambs. There are also many vineyards.

Of particular interest is the elegant (but, sadly, now-closed) Monte Cristo Homestead, an impressive two-storey Victorian mansion built in 1884–1885 by grazier and developer Christopher William Crawley. In 1876 Crawley bought 210ha of land on the town's west side and 130ha on the east, hoping to exploit the arrival of the Great Southern Railway, which opened in 1878. He built the Railway Hotel and soon made his fortune.

Monte Cristo was Crawley's statement about his importance in Junee. It sits on the hill overlooking the town and is the district's finest house. Today, however, it's also known as 'Australia's Most Haunted House', and television and radio programs have been made about it and its chilling tales. Ghost hunters from the Sydney Spirit Stalkers and other arcane organisations have spent nights at the homestead, hoping to commune with the dead. Paranormal phenomena documented at the house include unexplained bright lights, visions of figures, feelings of sadness in some rooms, difficulty breathing in certain rooms, hearing voices, and mists appearing in photographs.

BRUCE ELDER


Old Junee
OLD JUNEE RD
QUEEN
ST
OLYMPIC
HWY
A41
WATERWORKS
RD
Cootamundra
Junee
Sydney
LORD
ST
PRINCE
ST
Junee North
REGENT
ST
Laurie Daley Oval
Junee Showgrounds
ST
CEDRIC
ST
BOUNDARY
2
BROADWAY
ST
MAIN
JOHN
PITT
ST
COMMINS ST
ST
POTTS
RD
Junee Urban Wetland
7
A41
SMYTHE RD
Wagga Wagga
DE SALIS
DR
GWYNNE PL
LOUGHAN
MONTE CRISTO
ST
DR
JOFFRE ST
SEIGNIOR ST
LORNE ST
4
6
5
Junee
LYDIA
BELMORE
ST
3
Junee Golf Club
A41
OLYMPIC
HWY
Junee Visitor Information Centre
GUNDAGAI
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Wagga Wagga
0 250 500 m

Junee is a 440km drive south-west of Sydney via the Hume Highway. It's a 40km drive north of Wagga Wagga and is 320m above sea level.

ORIGIN OF NAME

Junee is thought to be a Wiradjuri First Nations word meaning 'speak to me'. The town's name was originally spelt 'Jewnee'.

VISITOR INFORMATION

Junee Visitor Information Centre, 92 Lorne Street, Junee.

Phone: 02 6924 2111. Open 9am–5pm on weekdays, 9am–1pm on Saturdays, and 10am–2pm on Sundays.

USEFUL WEBSITE

youmeandjunee.com.au

PHOTO CREDIT: TOURISM AUSTRALIA

Junee's railway heritage is on full display at the Roundhouse Railway Museum (left). Visitors get their sugar fix at the Junee Licorice and Chocolate Factory (below).

Places of interest

1 ROUNDHOUSE RAILWAY MUSEUM

This impressive museum, located south of the town, is the only fully circular brick building in NSW. It surrounds a 32m train turntable, which was once the largest of its kind in the Southern Hemisphere. The museum's exhibits include a mail van, several locomotives, trikes and quadracycles, a steam crane that's still in working order, an accident van, and the original workshop that was so large it had 42 repair bays.

2 LICORICE AND CHOCOLATE FACTORY

At 45-61 Lord Street, the Junee Licorice & Chocolate Factory is housed in an old flour mill that was built in the 1930s. The factory makes a range of organic confectioneries and offers guided tours and hands-on experiences where you can make your own chocolate.

3 COURT HOUSE

On Belmore Street, the Junee Court House was designed by colonial architect James Barnet and built in 1890. It has a high ceiling, verandahs around the sides, a gabled roof and arched windows. The verandahs' cast-iron brackets bear the royal cypher VRI (Victoria Regina Imperatrix), dating them to the reign of Queen Victoria.

4 RAY WARREN STATUE

In Dobbyn Park near the railway station stands a statue of Ray Warren, the retired sports commentator who was born in Junee. Widely known as 'Rabbits' or 'Rabs', he's most famous for his coverage of televised professional rugby league matches on the Nine Network. The statue, which was unveiled in 2011, has a plaque that describes him as: "The voice of rugby league, born and bred in Junee."

5 RAILWAY STATION AND REFRESHMENT ROOMS

Junee's original railway station opened in 1878. The modest timber building was destroyed by fire in 1882 and later replaced with a sophisticated new building designed in the French Renaissance style. The station's elegant Refreshment Rooms were lit by gaslights and furnished with imported furniture. Today, the building is still in use. It's now a popular cafe.

6 LOFTUS HOTEL

On the corner of Main Street and Humphrys Street, the Loftus Hotel is a monument to the opulence of the town's early history. Today it's Junee's oldest and grandest establishment. It occupies an entire block.

7 BROADWAY MUSEUM

The museum, housed in the old Broadway Hotel on Broadway Street, has an extensive collection of photographs and memorabilia associated with the history of the town and the surrounding district.

Junee timeline

- Before European settlement, the area was home to the Wiradjuri First Nations people.
- **The 'Jewnee' pastoral run was established in the 1840s.**
- In 1861 James Harris founded the Jewnee Hotel. At the time, the area was a stagecoach stop between Temora, Wagga Wagga and Cootamundra.
- **Jewnee's post office opened in 1862. One year later the village was officially gazetted.**
- In 1863 the bushranging gang of Ben Hall (right) raided the village, held up the Jewnee Hotel, and raided a homestead, fleeing with five horses.

- **In 1866, 12 people lived in the village, until the discovery of several alluvial goldmining sites in the district – including Junee Reefs and Eurongilly – triggered a gold rush.**
- In 1876 grazier and businessman Christopher Crawley bought two plots of land in the area.
- **On 6 July 1878 the Great Southern Railway reached the district. The new railway settlement was known as Junee Junction but was formally renamed Loftus in 1883.**
- In 1884-1885 Crawley's famous Monte Cristo Homestead was built.
- **The town was gazetted in 1885 and, on the back of a petition from residents, its name was changed to Junee.**
- In 1952 Southern Hemisphere's largest wheat terminal was built near the town.
- **In 2011 a statue of Ray Warren was erected in Dobbyn Park.**

Since 1988 Bruce Elder has travelled to every town in Australia. He has written more than 10 travel books, including the Globetrotter Guides to Australia, Sydney and Queensland; *1015 Things to See and Do in Australia*, *Explore Queensland* and *Explore NSW*. He worked as a full-time travel writer with *The Sydney Morning Herald* and *The Age* from 1996 to 2012. *aussietowns.com.au*

PHOTO CREDITS, FROM TOP, CLOCKWISE FROM TOP: ALAMY; ALAMY; TOURISM AUSTRALIA

TRACES

BY ESME MATHIS

Farina, SA

This remote outback settlement (below) flourished into a thriving town when it became the railhead for the Central Australia Railway. Traces of its railway heritage can still be seen amid today's ruins (above and right).

THE CRUMBLING RUINS of Farina lie on a remote gibber plain in South Australia's arid Far North, about 650km north of Adelaide. In the early 1880s this town was the railhead of the Central Australia Railway, providing a vital link between outback pastoralists and southern markets. But its strategic importance slowly faded when the railway line was extended north. Today it's a ghost town, a handful of hollowed-out stone buildings whose roofs, doors and windows are long lost to time.

Farina was founded in the 1870s near a reliable waterhole. It was originally called 'Government Gums' but was later renamed Farina, a Latin word that means 'flour' or 'meal'. (Several years of good rainfall had tricked the colonists into thinking the area was well-suited for growing crops.) The settlement began as a hodgepodge collection of tents, which were soon replaced by more permanent buildings made from timber and stone.

For early settlers, Farina's limited access to clean water was a constant source of anxiety. In early 1881, tainted water was killing cattle in the region and causing sickness in families, despite colonial authorities declaring the water quality was "good enough for most purposes". On 26 February 1881 a writer for the *South Australian Register* published a scathing response to this comment, stating: "If the water here is 'good enough for most purposes', why is it that our Government officials have to send sixteen miles for drinkable water? Perhaps, though, the constitution of Government officials…is so delicate that they cannot be expected to drink what any other mortal can."

In 1882 the arrival of the Central Australian Railway led to a brief boom in Farina's economy. The town became a vital livestock dispatch point for outback drovers across the colony. These drovers, travelling on the Oodnadatta Track (from north SA), the Strzelecki Track (north-east SA) and the Birdsville Track (south-west Queensland), all converged on Farina to dispatch their cattle and sheep to southern markets. Other goods such as wool bales and locally mined copper and silver were also transported out of Farina during this time.

Money poured into the town, and its population eventually grew to 600 people. A steady stream of visitors passed through, including Chinese miners and Afghan cameleers. On 18 August 1882 a reporter for the *Burra Record* wrote: "It would be difficult to imagine a more desolate place than the [Government] Gums for scenery, although the newcomer cannot fail to be struck by the variety that meets his eye in the way of inhabitants."

At its peak, Farina had two hotels, two breweries, five blacksmiths, a bakery, a post office, a church, a brothel, a general store and a school. Newspaper archives offer a window into its close-knit community. On 30 April 1886 *The Port Augusta Dispatch* ran a report on Farina's Easter celebrations, which included cricket matches (married men vs. bachelors) and a ball that "was well attended, dancing being enthusiastically kept up till about 3am".

The town's slow decline began when the Central Australia Railway line was extended to Marree in 1884, then further north to Oodnadatta in 1891. Still, Farina continued to be a livestock transportation station well into the 20th century.

The town was abandoned in the 1980s. Many of its original timber structures have not survived into the 21st century, but its stone buildings have been preserved by the Farina Restoration Group. The town is now a popular tourist spot and campsite.

MORE INFO: *farinarestoration.com*

AUSQUIZ ANSWERS

1) Red kangaroo **2)** Neale Daniher **3)** Western Australia **4)** Omnivore **5)** Mt Bogong **6)** False **7)** Queensland **8)** Paul Keating **9)** Boorloo **10)** Tamworth **11)** *Acacia* **12)** The Arrernte people **13)** Yorke and Fleurieu **14)** Five (QLD, NSW, ACT, VIC and SA) **15)** The Battle of Bitapaka (New Guinea) **16)** Yellow **17)** South Point (Wilsons Promontory) **18)** $20 banknote **19)** Franklin River **20)** New South Wales **21)** Charles Kingsford Smith **22)** Tree hollows **23)** Tim Winton **24)** Frederickstown (now Albany) **25)** ANZUS treaty **26)** Emma McKeon **27)** Pink mulla mulla **28)** Peacock spider **29)** Old Museum Building **30)** Henry Lawson **31)** *Grevillea* **32)** Parrotfish

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